Hornsea Project Three
Offshore Wind Farm

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Offshore Wind Farm

Response to the Secretary of State's Consultation
Appendix 4: Post Examination Mitigation and Project Envelope Modifications

Date: February 2020

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Response to the Secretary of State's Consultation

Appendix 4: Post Examination Mitigation and Project Envelope Modifications

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Front cover picture: Kite surfer near a UK offshore wind farm © Orsted Hornsea Project Three (UK) Ltd., 2018.

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1. Background

1.1 On 27 September 2019, the Secretary of State issued a consultation request (the Consultation) inviting submissions and evidence from the Applicant on matters relating to in-combination impacts on the assemblage of kittiwake feature of the Flamborough and Filey Coast Special Protection Area (FFC SPA) and the impacts of cable protection on protected seabed features of the Wash and North Norfolk Coast (WNNC) Special Area of Conservation (SAC), the North Norfolk Sandbanks and Saturn Reef (NNSSR) SAC and the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ).

1.2 It is noted the Secretary of State confirmed that the Consultation is without prejudice to her final decision on the Application and is not to be taken to imply any conclusions that may be reached. The Applicant remains confident of its position (of no adverse effect on integrity of a European site and no significant risk to hindering the achievement of the conservation objectives of any MCZ) on the basis of the maximum design scenario (MDS) as set out during Examination. The Applicant has continued to vigorously re-appraise all elements of the MDS for Hornsea Three, in order to ensure the most efficient design solution. The Applicant has also continued to engage with the Marine Management Organisation (MMO) and Natural England to address the residual concerns on the topics of benthic ecology and offshore ornithology.

1.3 This note provides a summary of the additional mitigation and design refinements the Applicant is now committing to, specifically:

- Section 2.1 presents mitigation to reduce collision effects on ornithological features, but particularly kittiwake populations of the FFC SPA;
- Section 2.9 presents project design modifications with respect to cable protection measures within the WNNC SAC, the NNSSR SAC and the Cromer Shoal Chalk Beds MCZ.
- Section 2.13 presents Principles for identification of sandwave clearance disposal locations within the two SACs and the Cromer Shoal Chalk Beds MCZ.
- Section 2.19 presents the Applicant's commitment to avoid placement of infrastructure within Markham's Triangle MCZ.

1.4 Where relevant, additional mitigation and design refinements have been secured in the revised draft Development Consent Order (dDCO) submitted alongside this document (Appendix 9 to the Applicant's Response).

1.5 Further detail on the mitigation and design modifications and their implications for the relevant marine protected areas are appended to this document and referred to in the relevant sections below. The implications of these changes to the project description on the conclusions of the Hornsea Three impact assessments for offshore topic chapters (Volume 2, Chapters 1 to 11 of the Environmental Statement (APP-061 to APP-071)) are presented in Annex A to this note.

1.6 Section 3 presents the mitigation and design modifications committed to as part of the project at the end of the Hornsea Three Examination (i.e. Deadline 10), which were relevant to designated benthic ecological features of the marine protected areas outlined above.

2. Post examination design envelope modifications

Ornithology mitigation

2.1 During the Hornsea Three Examination, the Applicant considered how collision rates could be mitigated by raising the height of the turbine blades above the sea surface and therefore moving the rotor swept area to altitudes where bird densities are lower due to the skewed nature of bird flight height distribution (Johnston *et al.,* 2014). Collision Risk Modelling (CRM) indicates that this is an effective way of reducing the collision risk. The Applicant agreed that if considered necessary by the Secretary of State in order to conclude no adverse effect on integrity in respect of FFC SPA, turbines could be raised by approximately 4.33 m (REP7-030). This would lead to an increase in the lower rotor tip height (sometimes referred to as the air gap) from 33.17 m to 37.5 m (above mean sea level (MSL)) (34.97 m to 39.3 m (LAT)). The effect of this change reduced the predicted collision rate for kittiwake by approximately 24-34% (depending on the parameter assumptions used) when the collision risk estimates for the 33.17 m lower tip height scenario are compared to those for the 37.5 m lower tip height scenario. The Applicant also presented the effect of increasing the lower rotor tip height to 40 m MSL, but did not commit to this additional mitigation for the reasons set out in REP7-030.

2.2 Following the Examination of Hornsea Three, the Applicant has continued to explore options which further reduce the risk of collision mortality of seabirds and can now commit to the following design envelope refinements:

- Increase the lower blade tip height from 33.17 m to **40 m** at MSL (34.97 m to 41.8 m (LAT))
- 23% reduction in the maximum number of turbines from 300 to **231**
- 2.2% reduction in the rotor swept area from 9.0 km^2 to **8.8** $\mathbf{km^2}$

2.3 These design envelope refinements have been secured within the revised dDCO accompanying this Submission (Schedule 1, Part 3, Requirement 2(1) and 2(2)(c) and Schedule 11, Part 2, Condition 1(1) and 1(2)(c) of the draft DCO; Appendix 9 to the Applicant's Response).

2.4 Table 2.1 below compares collision risk estimates for kittiwake at the FFC SPA for the refined design envelope (for Hornsea Three alone) to those presented in Examination for the 33.17 m and 37.5 m lower rotor blade tip height (as presented in Sections 5 and 6, of REP7-031 and Table 3.3 and Table 3.4 of REP9-047, respectively), for each set of modelling assumptions presented in Annex B of this note.

2.5 For the Applicant's position, the refined design envelope results in a 40.9% or 21.2% reduction in collision risk to the FFC SPA population of kittiwake when comparing with the 33.17 m and 37.5 m (both MSL) lower rotor tip height scenarios, respectively, with a similar magnitude of reduction estimated when using the parameters requested by the Examining Authority (PD-020 and REP9-047). When using the Applicant's understanding of Natural England's position, the resulting collision risk estimates calculated when using the refined design envelope represent a **59.4%** or 38.4% reduction when compared to those collision risk estimates calculated during Examination, for the 33.17 m and 37.5 m lower rotor tip height scenarios, respectively.

2.6 When applying the Applicant's position, the collision rate is now reduced to 4 collisions/annum alone and 111 in-combination. When applying the Applicant's interpretation of Natural England's position, the collision rate is reduced to 65-73 collisions/annum alone and 315-323 in-combination. When applying those parameters requested by the Examining Authority, the collision rate is 7-9 collisions/ annum and either 257-259 in-combination (if applying the Basic version of the Band 2012 CRM to all other projects) or 114-116 (if applying the Extended version of the CRM where available for other projects)[1].

2.7 The differences between the three positions presented above are due to the different parameter assumptions used by the Applicant, Natural England and the ExA, respectively. Of the three sets of parameters those of the Applicant and the Examining Authority provide the most similar appraisal of collision risk for the kittiwake population at FFC SPA. This is due to alignment in those parameters that have the largest effect on collision risk estimates namely Band model Option, and breeding season apportioning rate.

2.8 Supporting information on the results of CRM presented in Examination and for the refined design envelope can be found in Annex B of this note.

[1] The Examining Authority did not request in-combination totals as part of PD-020 and therefore such totals were not presented in REP9-047. In-combination totals calculated when using both the Basic and, where available, Extended versions of the Band CRM are therefore presented here.

Table 2.1: Comparison between collision risk estimates for kittiwake at FFC SPA.

		Parameter scenario		
		Applicant	Natural England (assumed parameters)	Examining Authority
Collision risk estimate apportioned to FFC SPA (upper and lower confidence intervals) for Hornsea Three alone	Examination: 33.17 m MSL lower rotor height[2]	7 (4-10)	181 (112-257)	13-15 (8-9 to 18-21)
	Examination:37.5 m MSL lower rotor height	5 (3-7)[2]	119 (74-169)[2]	10-11 (6-7 to 14-16)[3]
	Refined design envelope: (reduction in rotor swept area to 8.8 km2, reduction in number of turbines to 231 and increase lift to 40 m MSL lower rotor height)	4 (3-6)	65-73 (40-46 to 91-104)	7-9 (5-5 to 11-12)
% reduction (33.17 m lower rotor height to updated mitigation scenario)		**40.9**	**59.4**	**41.4**
% reduction (37.5 m lower rotor height to updated mitigation scenario)		21.2	38.4	21.9

Cable protection in marine protected areas.

2.9 With respect to cable protection, the Applicant's position is that the placement of cable protection will not result in an adverse effect on the integrity of the NNSSR SAC and the WNNC SAC and will not represent a significant risk to the achievement of conservation objectives of the Cromer Shoal Chalk Beds MCZ. This is particularly the case given the Applicant's commitment to decommissioning cable protection at the end of the operation and maintenance phase, which will ensure permanent effects on the designated features of these marine protected areas are avoided (see Schedule 11, Part 2, Condition 24 and Schedule 12, Part 2, Condition 24 of the dDCO; Appendix 9 to Applicant's Response).

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[2] As set out in REP7-031
[3] As set out in REP9-047

2.10 Since the close of the Hornsea Three Examination, the Applicant has reduced the maximum design envelope for cable protection within marine protected areas. These reductions have been identified by considering remedial burial[4] as an alternative to deployment of cable protection in areas where the initial installation has not been successful (i.e. the depth of burial is not sufficient to provide protection to the operational cable). Table 2.2 provides a detailed justification for the reduction in the maximum design scenario within each of the marine protected areas coinciding with the Hornsea Three offshore cable corridor. These assess the likelihood of the success of remedial burial operations when considering the known ground conditions in those sections of the offshore cable corridor. Based on the likely level of success of remedial burial, the proportions of the total length of export cables which may require cable protection have been revised down, with a lesser requirement in those areas where remedial burial is expected to be successful. The proportions of export cables where cable protection may be required have therefore been reduced from 10% of the total length of export cables within each marine protected areas, to 7% for the Cromer Shoal Chalk Beds MCZ and 6% for each of the WNNC SAC and the NNSSR SAC (see Table 2.2).

2.11 Table 2.2 provides further details of these reductions and the implications for the Report on Implications for European Sites (RIES) with the implications for Cromer Shoal Chalk Beds MCZ outlined in the updated MCZ Assessment (Appendix 5 to Applicant's Response), with a summary of these presented in Table 2.2.

Table 2.2: Summary of changes to maximum design scenario (MDS) for cable protection in marine protected areas and implications for assessments (see Annex C of this note).

Parameter	MDS in Examination	Revised MDS	Implications for RIAA and MCZ Assessment
North Norfolk Sandbanks and Saturn Reef SAC			
Maximum % of cables where remedial cable protection may be required	10%	**6%**	The maximum area affected by placement of cable protection (6% of maximum length of export cables) represents 0.01% of the total area of the Annex I sandbanks feature of the SAC (unchanged from the 0.01% of the total area of the Annex I sandbanks feature in the RIAA, but reduction in the footprint by 78,960 m²).
MDS Footprint of cable protection[1] (m²)	497,400 m²	**418,440 m²**	
Wash and North Norfolk Coast SAC			
Maximum % of cables where remedial cable protection may be required	10%	**6%**	The maximum area affected by placement of cable protection (6% of maximum length of export cables) represents 0.0026% of the total area of the Annex I

[4] Remedial burial may involve tools such as jet trenchers or controlled flow excavators, or similar tools, to lower the cable beneath surface sediments in order to achieve the target depth of burial in the particular ground types present. This may be used in suitable sediments as an alternative to secondary cable protection (e.g. rock protection).

Parameter	MDS in Examination	Revised MDS	Implications for RIAA and MCZ Assessment
MDS Footprint of cable protection (m^2)	46,200 m^2	**27,720 m^2**	sandbanks feature of the SAC (previously 0.004% of the total area of the Annex I sandbanks feature, a reduction in the footprint by 18,480 m^2).
Cromer Shoal Chalk Beds MCZ			
Maximum % of cables where remedial cable protection may be required	10%	**7%**	The maximum area affected by placement of cable protection (7% of maximum length of export cables) represents 0.016% of the Subtidal Sand broadscale habitat feature within the MCZ (previously 0.02% of the Subtidal Sand feature, a reduction in the footprint by 1,260m^2).
MDS Footprint of cable protection (m^2)	4,200 m^2	**2,940 m^2**	

[1] For the NNSSR SAC, this includes the maximum design scenario for cable protection associated with asset crossings and remedial protection due to insufficient burial during installation. No asset crossings will be required for the WNNC SAC and the Cromer Shoal Chalk Beds MCZ.

2.12 As these changes in the maximum design scenario for cable protection have resulted in reductions in the proportions of designated features (and sub-features) affected by cable protection from Hornsea Three, this does not change the overall conclusions of the Report to Inform Appropriate Assessment (APP-051), i.e. that Hornsea Three will not result in an adverse effect on integrity of either the NNSSR SAC, or the WNNC SAC. Nor will it affect the overall conclusions of the MCZ Assessment with respect to Cromer Shoal Chalk Beds MCZ, i.e. that there is no significant risk from placement of cable protection during the operational phase with consequent habitat loss effects, hindering the achievement of the conservation objectives of the MCZ.

Sandwave clearance volumes

2.13 Since the close of the Hornsea Three Examination, the Applicant has conducted further geophysical surveys to inform engineering and cable installation requirements, notably along the offshore and nearshore re-routes[5], which reduced the length of the offshore cable corridor within marine protected areas. Some of the data collected during these surveys were previously presented within examination documents (i.e. the Preliminary Trenching Assessment; REP6-026), although further analysis of these datasets since examination have allowed the Applicant to further refine their project design parameters, particularly with respect to sandwave clearance volumes (discussed further below).

[5] Two re-routes of the Hornsea Three offshore cable corridor were implemented following section 42 consultation responses from Natural England during the pre-application phase. These were designed to reduce overall impact of cabling on designated sites (see REP1-138 for further detail).

2.14 Using the latest geophysical and geotechnical data for the offshore cable corridors, the Applicant has been able to refine the maximum design parameters for sandwave clearance volumes within the marine protected areas. This exercise was undertaken following the same methodology set out in the Sandwave Clearance Clarification Note (REP1-183), although incorporating the latest site specific geophysical and geotechnical datasets. The results of this exercise are summarised in Table 2.3 below.

2.15 These reductions in the maximum design scenario are captured within Table 4.1 of the outline Cable Specification and Installation Plan (OCSIP) which is presented at Appendix 6 to Applicant's Response. Table 2.3 provides details of the implications of these reductions on the RIES with the implications for Cromer Shoal Chalk Beds MCZ outlined in the updated MCZ Assessment Appendix 5 to Applicant's Response (summarised in Table 2.3 below).

Table 2.3: Summary of changes to maximum design scenario (MDS) for sandwave disposal volumes in marine protected areas and implications for assessments. Note: there was no change to the maximum sandwave clearance volumes within the NNSSR SAC (see Annex D of this note).

Parameter	MDS in Examination	Revised MDS	Implications for RIAA and MCZ Assessment
Wash and North Norfolk Coast SAC			
Maximum volume of sandwave material which could be disposed of within the SAC (m^3)	132,737 m^3	**48,000 m^3**	Maximum footprint of construction related temporary habitat loss is predicted to be up to 2,187,240 m^2, which represents 0.20% of the total area of the Annex I sandbanks feature within the SAC (previously these values were up to 2,356,714 m^2 or 0.22% of the total area of this Annex I feature; see Annex D of this note).
Cromer Shoal Chalk Beds MCZ			
Maximum volume of sandwave material which could be disposed of within the MCZ (m^3)	1,400 m^3	**1,000 m^3**	Maximum footprint of construction related temporary habitat loss is predicted to be up to 190,400 m^2, which represents 1.03% of the Subtidal Sand feature within the MCZ (previously these values were up to 191,200 m^2 or 1.04% of the Subtidal Sand feature; see updated MCZ Assessment (Appendix 5 to Applicant's Response)

Sandwave clearance disposal locations

2.16 The dDCO accompanying this submission (Appendix 9 to Applicant's Response) includes conditions which commit to working with the MMO and Natural England, via the CSIP, to identify suitable locations for disposal of material dredged during sandwave clearance activities within respective designated sites (see Schedule 11, Part 2, Condition 13(1)(h)(ii) and Schedule 12, Part 2, Condition 14(1)(h)(ii); of the dDCO; Appendix 9 to Applicant's Response). The Applicant's position is that these disposal locations (which will be located within the Order limits and within the designated site from which the material was dredged) can be developed with the MMO and Natural England, post-consent. This is to ensure that the locations are identified and agreed based on the best available and most up to date survey data and project envelope, ensuring that effects on designated features of the relevant marine protected areas and other users are minimised wherever possible.

2.17 The Applicant has worked with MMO and Natural England to develop a number of Principles for selection of sandwave clearance disposal locations within marine protected areas, with separate principles developed for the offshore disposal (i.e. NNSSR SAC) and the nearshore disposal (i.e. WNNC SAC and Cromer Shoal Chalk Beds MCZ) areas. The aim of these is to ensure that effects of disposal on designated features are minimised, e.g. avoidance of Annex I reef habitats with appropriate buffers for nearshore and offshore reefs, and minimising change of sediment type within marine protected areas by matching sediment type of the material to be disposed to that of the receiving environment.

2.18 These Draft Principles for Identification of Sandwave Clearance Disposal Locations are presented in the updated outline CSIP which is presented at Appendix 6 to Applicant's Response. **At this stage, these are draft and the Applicant is continuing to engage with the MMO and Natural England during the consultation period following submission of the Applicant's Response, with a view to agreeing these with all parties by the end of the 28 day consultation period.**

Infrastructure within Markham's Triangle MCZ

2.19 The Applicant has committed to avoiding placement of any infrastructure (i.e. foundations, scour protection, cables and associated cable protection) within the boundary of Markham's Triangle MCZ.

2.20 The Applicant maintains its position that the project did not represent a significant risk to hindering the achievement of the conservation objectives of Markham's Triangle MCZ, based on the maximum design envelope presented at the end of Examination. However, following consultation with Natural England and the MMO since the end of Examination, the Applicant further reviewed the maximum project design parameters for the Hornsea Three infrastructure which could be placed within Markham's Triangle MCZ (from those committed to during Examination), in order to facilitate agreement with Natural England with respect to the need for a Stage 2 MCZ Assessment. This proposal was provided to Natural England and the MMO for comment in December 2019. However, whilst the optimum layout would make use of Markham's Triangle, following the reductions in infrastructure as set out for ornithology (see Section 2.1; specifically the reduction in number of turbines from 300 to 231), the Applicant can now commit to the avoidance of placement of any infrastructure within Markham's Triangle MCZ.

2.21 This is committed to within the generation and transmission dMLs (see Schedule 11, Part 2, Condition 2(9) and Schedule 12, Part 2 Condition 2(11)) of the updated dDCO; Appendix 9 to Applicant's Response) and the implications of this change are considered in an updated MCZ Assessment (Appendix 5 to Applicant's Response).

3. Mitigation and design modifications committed to as part of the project (at Deadline 10 of the Hornsea Three Examination).

3.1 Throughout the pre-application phase and during Examination, the Applicant has committed to mitigation measures to minimise impacts on features of SACs and MCZs and monitoring to either support these measures and/or validate the predictions made within the Environmental Statement/RIAA. Full details of these commitments are set out in Table 5.1 of the Benthic Impacts Control Plan (REP10-027), but are summarised below.

Table 3.1: Summary of Hornsea Three mitigation and monitoring commitments

Measure	Detail
Mitigation	
Micrositing around Annex I reefs	Commitment to avoidance of Annex I reefs within and outside marine protected areas, with pre-construction surveys to be scoped to identify and delineate Annex I reefs, with a view to micrositing export cables within the limits of deviation provided for within the Order limits, to avoid direct impacts on these. Adjustment to the Work Plans during examination to extend a short section of the Hornsea Three offshore cable corridor into the adjacent temporary working areas within NNSSR SAC, to provide additional space for micrositing around Annex I reefs (should these be present) and maximise effectiveness of the primary mitigation (see REP6-038).
Cable protection	Commitment to the use of 'sensitive' cable protection material within designated sites including the SACs, i.e. rock sizes that reflect the baseline environment as much as possible. This will minimise change in sediment/substrate to allow some continuing ecological function.
Decommissioning	Commitment to decommission remedial cable protection within marine protected areas, subject to agreement with the MMO and SNCBs. The Applicant is also willing to commit to undertaking a study to validate the effectiveness and test further efficiencies of rock protection decommissioning methods and investigate possible efficiencies associated with decommissioning methodologies (see section 5.3 of REP10-027).
Design modifications, including reduction in cable lengths within marine protected areas	The re-route of the offshore cable corridor around part of the NNSSR SAC (implemented following section 42 consultation during the pre-application phase) led to a reduction in the maximum extent of cable corridor within the NNSSR SAC from 60 km to 47 km. There was also a reduction in the maximum level of cable protection applied within the NNSSR SAC from approximately 1,079,400 m^2 to 497,800 m^2 (in part due to the offshore cable corridor re-route for the NNSSR SAC).

Measure	Detail
Monitoring (see Hornsea Three In-Principle Monitoring Plan; REP9-066)	
Sandwave recovery	Monitoring to confirm recovery timescales of sandwaves following clearance within the SACs
Cable installation and recovery of seabed	Monitoring to confirm recovery of seabed sediment and benthic habitats (i.e. Annex I sandbank features and sub-features) following cable installation
Cable protection monitoring	Monitoring to confirm the level of sedimentary and ecological change on and in the vicinity of deployed cable protection
Annex I reef monitoring	Monitoring to confirm effectiveness of micrositing during cable installation, i.e. no direct impacts on Annex I reef features. Linked to Proposal to Aid Achievement of Conservation Objectives set out below.

Proposals to Aid Achievement of Conservation Objectives for the NNSSR and WNNC SACs

3.2 In addition to the mitigation outlined above, the Benthic Impacts Control Plan outlined four potential proposals for consideration relating to the NNSSR and WNNC SACs which are intended to be collaborative projects aimed at helping achievement of conservation objectives of these sites (full details of these proposals were presented at REP9-050.

3.3 The Applicant would note that these proposals were put forward on the basis that the Secretary of State would conclude that Hornsea Three will not lead to an adverse effect on integrity of the SAC. Whilst three of the proposals would not represent mitigation to reduce impacts on features of the designated sites, these proposals demonstrate the Applicant's commitment to support SNCBs with achieving conservation objectives of the relevant designated sites (particularly the WNNC SAC and the NNSSR SAC) which coincide with the Hornsea Three Order Limits. The Applicant will continue to engage on the scope of these proposals with Natural England should the Secretary of State determine that Hornsea Three will not lead to an adverse effect on integrity of the SAC. The fourth study on decommissioning of rock protection has been proposed to validate and improve efficiencies of mitigation which has been committed to by the Applicant (i.e. decommissioning of rock protection at the end of operation; see Table 3.1) and therefore this is an extension of this mitigation.

3.4 Full details of these are set out in REP9-050 and within the Benthic Impacts Control Plan (REP10-027), but in summary, these comprise:

- A collaborative project with JNCC to help quantify the amount of infrastructure within the NNSSR SAC, to allow for further studies to be scoped to provide further evidence on effects that these existing infrastructure are having on the Annex I features of the SAC;
- A collaborative project with JNCC and NE to determine the extents and condition of Annex I *S. spinulosa* reefs in the north west section of the SAC, including repeated surveys to provide a time series of the extents and condition of these reef habitats over time.

- A collaborative project with the Eastern IFCA to investigate the effectiveness of their proposed fishery closure within the WNNC SAC to protect sub-features of the Annex I sandbanks feature, which will also improve the knowledge of condition of the SAC along the North Norfolk Coast.

  A study to validate the effectiveness and test further efficiencies of rock protection decommissioning methods to the NNSSR and WNNC SACs and investigate possible efficiencies associated with these methodologies.

Annex A: Implications of design changes on impact assessment

As outlined in Section 2 of the main document, there have been a number of modifications to the project design envelope for Hornsea Three since the close of examination to reduce impacts on designated features of designated sites, specifically:

- Reduction in the maximum number of turbines;
- Reduction in maximum rotor swept area;
- Increase in the minimum lower tip height above mean sea level;
- Removal of infrastructure from Markham's Triangle MCZ (facilitated by the reduction in maximum number of turbines);
- Reduction in the maximum volume of sediment to be disposed of within marine protected areas; and
- Reduction in the maximum volume and footprint of cable protection within marine protected areas.

This section considers the implications of these changes to the project description for the conclusions of the Hornsea Three impact assessments presented in Volume 2, Chapters 1 to 11. As all design changes outlined above, with the exception of increase in minimum lower tip height (discussed further below), represent reductions in project design parameters assessed within the Environmental Statement, these scenarios are within the maximum design scenarios assessed within the topic specific impact assessments presented in the Volume 2, Chapters 1 to 11 of the Environmental Statement (APP-061 to APP-071). That is, all of these reductions in the project design parameters will lead to a reduction in the magnitude of the impact on the relevant offshore receptors (e.g. for effects of underwater noise on fish and marine mammals, the construction duration will be shorter for 231 turbines and therefore will be within the maximum design scenario assessed within Volume 2, Chapters 3 and 4 of the Environmental Statement). Conversely, the Applicant would also note that the Project can achieve its generation capacity based on the amended project design and therefore the modifications outlined above will not negatively influence the benefits of the project (e.g. creation of jobs, investment and decarbonisation of the electricity network).

The reduction in the maximum number of turbines (from 300 to 231) and the maximum area within which turbines may be sited (to exclude Markham's Triangle MCZ) does not increase the maximum design scenario for those topics that considered indicative turbine layouts (e.g. Chapter 1: Marine Processes, Chapter 7: Shipping and Navigation, Chapter 10: Seascape and Visual Resources). This is because the assessments were based on the maximum number of turbines covering the entire Hornsea Three array area and as a result of the project refinements, there would now be fewer turbines within the Hornsea Three array area. All other project design parameters associated with the array area layout (as outlined in Volume 4, Annex 3.7: Development Layout Principles of the Environmental Statement; APP-091) remain unchanged. There is therefore no change to the magnitude of the impacts and therefore no alteration to the conclusions of the assessment within the Environmental Statement.

The implications of the increase in the minimum lower tip height from 33.17 m MSL (as considered in the Environmental Statement) to 40 m MSL (see Section 2.1 of the main document) are presented in Table 3.2 below for those chapters where tip height is considered as a parameter in the impact assessment. In conclusion, the change to the minimum lower tip height would not result in any new significant effects nor would it result in any changes to previously identified significant effects and assumptions related to these conclusions. The following offshore topics do not consider tip height as a parameter in the impact assessment and are therefore not presented in Table 3.2.

- Volume 2, Chapter 1: Marine Processes of the Environmental Statement (APP-061);
- Volume 2, Chapter 2: Benthic Ecology of the Environmental Statement (APP-062);
- Volume 2, Chapter 3: Fish and Shellfish Ecology of the Environmental Statement (APP-063);
- Volume 2, Chapter 4: Marine Mammals of the Environmental Statement (APP-064);
- Volume 2, Chapter 6: Commercial Fisheries of the Environmental Statement (APP-066);
- Volume 2, Chapter 7: Shipping and Navigation of the Environmental Statement (APP-067);
- Volume 2, Chapter 9: Marine Archaeology of the Environmental Statement (APP-069); and
- Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement (APP-071).

Table 3.2: Consequence of proposed change to minimum lower tip height on offshore EIA topics.

Relevant Impacts	Implications for impact assessment
Volume 2, Chapter 5: Offshore Ornithology of the Environmental Statement (APP-065)	
Operation and Maintenance Phase Mortality from collision with rotating turbine blades	Reduction in maximum design scenario considered within the Environmental Statement and Report to Inform Appropriate Assessment, with reductions in the number of birds (particularly kittiwake) affected as a result of the design envelope modifications. See Section 2.1 of the main document.
Volume 2, Chapter 8: Aviation, Military and Communication of the Environmental Statement (APP-068)	
Operation and Maintenance Phase Wind turbines and hoist operations will form an aerial obstruction resulting in disruption to cross – zone transit helicopter traffic, and Hornsea Three infrastructure will form an aerial obstruction resulting in disruption to helicopters using HMRs. Wind turbines will form a physical obstruction and may disrupt helicopter access, including requirements for decommissioning, to oil and gas platforms. Wind turbines will form an aerial obstruction and may disrupt helicopter access to helideck equipped drilling rigs and vessels conducting operations at subsea infrastructure and well locations. Wind turbines may disrupt radar coverage of NATS Claxby PSR and the Military ADR located at Staxton Wold and Trimingham.	While tip height is one of the parameters considered as part of the maximum design scenario for these impacts, the parameter considered is the maximum tip height and therefore the change to minimum tip height will result in no change to the operation and maintenance phase impact assessments.
Volume 2, Chapter 10: Seascape and Visual Resources of the Environmental Statement (APP-070)	

Relevant Impacts	Implications for impact assessment
Construction Phase The temporary change to the existing present day seascape character through the introduction of new or uncharacteristic elements/features during the construction phase may cause direct or indirect effects. ***Operation and Maintenance Phase*** The existing present day seascape character may change during the operational phase through the introduction of new or uncharacteristic elements/features. The night time visual scenario experienced by a variety of visual receptors during the operational phase may change.	While tip height is one of the parameters considered as part of the maximum design scenario for these impacts, the parameter considered is the maximum tip height and therefore the change to minimum tip height will result in no change to the construction and operation and maintenance phase impact assessments.

Annex B: Revised Ornithological Mitigation Scenario

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Response to the Secretary of State's Consultation
Appendix 4 Annex B: Revised Ornithological Mitigation Scenario

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Appendix 4 Annex B: Revised Ornithological Mitigation Scenario

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1. Introduction

1.1 In her letter dated 27 September 2019, the Secretary of State requested further consultation on the in-combination impacts on the kittiwake feature of the Flamborough and Filey Coast Special Protection Area (FFC SPA). Although the Applicant remains confident of its position (of no AEOI) on the basis of the maximum design scenario (MDS) as set out during Examination, the Applicant has taken the opportunity afforded by the Consultation to vigorously re-appraise all elements of the MDS for Hornsea Three, in order to ensure all feasible mitigation has been deployed. This note focusses on mitigation to further reduce potential adverse effects on the kittiwake feature whilst information on compensatory measures is included in Appendix 2 to Applicant's Response of the Hornsea Three submission to the Secretary of State.

1.2 Following the Examination of the Hornsea Project Three (Hornsea Three) application on 2 April 2019, the Applicant has continued to explore options which further reduce the risk of collision mortality of seabirds. This note recaps the results of collision risk modelling (CRM) presented in Examination, summarises the post-examination comparative ornithological data submitted to the Secretary of State on 31 July 2019[1], and presents and commits to additional design modifications to further reduce ornithological collision rates for all species. These additional design modifications are then secured in the Draft DCO.

1.3 The Hornsea Three application included an assessment of seabird collision risk. This assessment highlighted a risk to, amongst other species, kittiwake and specifically the breeding population of kittiwake which is a qualifying feature of the FFC SPA. The Applicant included information to inform the Habitats Regulations Assessment (HRA) as part of the Application to enable the Department for Business, Energy and Industry Strategy (BEIS), on behalf of the Secretary of State (as competent authority), to undertake an Appropriate Assessment of the effects of Hornsea Three on FFC SPA (and other European sites).

1.4 The assessment undertaken at Application submission stage considered a worst case scenario for seabird collision risk comprising 300 turbines with a maximum rotor swept area of 9 km^2 and a lower rotor tip height at Mean Sea Level (MSL) of 33.17 m. This scenario was chosen from the proposed design envelope because it results in the highest seabird collision rate from the potential turbine options available to the Applicant at time of Application.

[1] NIRAS Consulting (2019). Hornsea Project Three Offshore Wind Farm Ornithology Baseline Data Comparison. [Online]. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-003104-Applicants%20Post-Examination%20Submission.pdf (Accessed January 2020).

1.5 During Examination the approach and assumptions to collision risk modelling presented in the Applicant's Environmental Statement (ES) Volume 5, Annex 5.3: Collision Risk Modelling (APP-109) were extensively discussed in light of statements made by Natural England and the RSPB. This led to a range of collision risk scenarios being presented at Deadlines 7 and 9 (REP7-031 and REP9-047) that reflected the modelling parameters preferred by the Applicant, those assumed to be preferred by Natural England and, those requested by the Examining Authority (ExA). Each of these modelling scenarios leads to a different predicted collision mortality rate.

1.6 In addition, during the Examination, the Applicant considered how collision rates could be mitigated by raising the height of the turbine blades above the sea surface and therefore moving the rotor swept area to altitudes where bird densities are lower due to the skewed nature of bird flight height distribution (Johnston *et al.,* 2014). CRM indicates that this is an effective way of reducing the collision risk. The Applicant agreed that if considered necessary by the Secretary of State in order to conclude no adverse effect on integrity in respect of FFC SPA, turbines could be raised by approximately 4.33 m (REP7-030). This would lead to an increase in the lower rotor tip height (sometimes referred to as the air gap) from 33.17 m to 37.5 m (above mean sea level (MSL)) (34.97 m to 39.3 m (LAT)). The effect of this change is to reduce the predicted collision rate for kittiwake by approximately 24-34% (depending on the parameter assumptions used) when the collision risk estimates for the 33.17 m turbine scenario are compared to those for the 37.5 m turbine scenario. The Applicant also presented the effect of increasing the lower rotor tip height to 40 m MSL (41.8 m LAT), but did not commit to this additional mitigation for the reasons set out in REP7-030.

1.7 Following completion of the Examination, the Applicant has sought to validate the ornithological evidence provided in Examination. To this end, the Applicant obtained supplemental data on seabird densities for the non-breeding period of January through March. These data were analysed and summarised in a report submitted to BEIS/ Secretary of State on 31st July 2019 (and published on the Planning Inspectorate's website on 27 September 2019 as part of this Secretary of State consultation) and are not discussed further in this note. However, the key conclusion drawn by the Applicant from those data is that the densities observed during these months were similar to those obtained during the baseline surveys used to inform the offshore ornithological chapter of the ES (APP-065) and the RIAA (APP-051) (within the variability to be expected for surveys of this type) and would not significantly change the predicted collision rate under any scenario. To maintain consistency with previous modelling exercises, these data have not been included in the additional CRM presented in this note. Natural England have provided comments on this analysis and the Applicant's response to these comments is presented in Appendix A to this document.

1.8 In terms of mitigation, the Applicant can now commit to increasing the lower rotor tip height to 40 m (above MSL) and has explored options to reduce the number of turbines to be deployed. The predicted collision rate is directly and linearly related to the number of turbines. A reduction in the number of turbines of 10%, for example, will, if all other parameters and assumptions remain constant, lead to a 10% reduction in the predicted collision rate.

1.9 The updated mitigation scenario modelled, therefore, comprises:

- A total swept area of up to 8.8 km^2 comprised of no more than 231 turbines; and
- A lower rotor tip height of 40 m (above MSL) (41.8 m LAT).

1.10 This scenario reduces collision risk estimates for Hornsea Three alone by approximately 21%, 38% and 22% (when compared to the 35.7 m HAT turbine scenario as presented in REP7-031) lower when applying the Applicant's position, the Applicant's interpretation of Natural England's position and the parameters requested by the Examining Authority.

1.11 Section 2 summarises the results of previous CRM presented during Examination with Section 3 presenting the predicted collision rates for the updated mitigation scenario.

2. Summary of previous collision risk modelling (CRM) predictions

2.1 The risk of collision mortality for kittiwake was predicted for Hornsea Three using a standard CRM approach described in APP-109. The EIA and HRA submitted with the Application included CRM predictions for a worst case design scenario comprising: 300 turbines with a maximum rotor swept area of 9 km^2 and a lower rotor height of 33.17 m (MSL). The predicted impact is described and assessed in the Applicant's ES Volume 2, Chapter 5: Offshore Ornithology (APP-065) and Report to inform Appropriate Assessment (RIAA) (APP-051).

2.2 During Examination there was discussion about the appropriate methods and assumptions for CRM which led to different positions on the appropriate parameters to be used in the collision risk model. Eventually, three sets of assumptions were used for CRM: those advocated by the Applicant; those assumed to represent the position of Natural England; and, those that were specifically requested by the Examining Authority. These different sets of assumptions are summarised and compared in Table 2.1.

Table 2.1: Parameters of the relevant parties in relation to CRM for kittiwake

Parameter	Applicant (REP6-042)		Applicant's interpretation of Natural England's position (REP6-043)		Examining Authority (PD-020)	
	Value	Reference	Value	Reference	Value	Reference
Flight speed	8.71	Skov *et al.* (2018)	13.1	Alerstam *et al.* (2007)	13.1	PD-020
Avoidance rate (%)	99.0	Bowgen and Cook (2018)	98.9	JNCC *et al.* (2014)	99.0	PD-020
Band model Option	1/3	REP6-042	2	REP1-211	1	PD-020
Breeding season apportioning (%)	41.7	APP-054	Unknown – range applied with the worst case scenario (87.9%) presented	REP1-211	41.7	PD-020
Seasonality (breeding season)	Apr-Jul	APP-054	Mar-Aug	REP1-211	Mar-Aug	PD-020

Parameter	Applicant (REP6-042)		Applicant's interpretation of Natural England's position (REP6-043)		Examining Authority (PD-020)	
	Value	Reference	Value	Reference	Value	Reference
Nocturnal activity factor	Breeding = 20% Non-breeding = 17%	MacArthur Green (2018)/Furness (unpub)	2-3	REP1-211	2-3	PD-020

2.3 In addition, during Examination the Applicant identified and explored the implications of mitigation to reduce the predicted collision rate by increasing the lower rotor tip height (air gap) to 37.5 m (at MSL) whilst keeping the number of turbines at 300. The results of this modelling are presented in REP7-031 (Applicant and Natural England positions) and REP9-047 (Examining Authority position).

2.4 The resulting collision rate, for each set of assumptions is summarised in Table 2.2. Note that these are the collision rates for kittiwake apportioned to the FFC SPA.

Table 2.2: Collision risk estimates for kittiwake apportioned to FFC SPA calculated for the Applicant, Natural England's assumed and Examining Authority positions.

	Parameter scenario		
	Applicant	Applicant's interpretation of Natural England's parameters	Examining Authority
Collision risk estimate apportioned to FFC SPA (upper and lower confidence intervals)	5 (3-7)	119 (74-169)	10-11 (6-7 to 14-16)
Source	Table 6.16 in REP7-031	Table 6.16 in REP7-031	Table 3.4 in REP9-047

3. Updated mitigation scenario

3.1 Further consideration has been given to the design of Hornsea Three to reduce the risk of collision mortality. The revised scenario, which the Applicant is committed to, includes the following elements designed to limit predicted collision rates:

- Increase lower rotor height to 40 m (at MSL)
- Reduce maximum number of turbines to 231
- Limit rotor swept area to 8.8 km^2

3.2 Details of the collision risk arising from this revised scenario are provided below.

Collision risk modelling (CRM)

3.3 The risk of this updated mitigation scenario has been modelled using the parameters presented in Table 3.1 and Table 3.2.

Table 3.1: Wind farm and turbine parameters for the updated mitigation scenario used in CRM

Component	Parameter	Value
Wind farm	Latitude (degrees)	53.87
	Maximum number of turbines	231
	Tidal offset (m)	-
Turbine	Average rotational speed (rpm)	7.8
	Rotor radius (m)	110
	Hub height (m)	150 (MSL)
	Max blade width (m)	6
	Average pitch (°)	6

Table 3.2: Monthly proportion of time turbines at Hornsea Three will be operational.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Proportion of time operational (%)	92.50	92.61	92.14	90.96	90.71	89.36	89.18	89.86	91.29	92.57	92.59	92.61

3.4 All other parameters and assumptions are the same as those used in the calculations presented during Examination.

Collision rates for Hornsea Three alone

3.5 The predicted kittiwake collision rates, apportioned to the FFC SPA for Hornsea Three alone are presented in Table 3.3. Collision rates are presented for the parameter scenario advocated or requested by each party as previously presented in Table 2.1 above.

Table 3.3: Collision risk estimates (with associated confidence intervals for density data) for kittiwake calculated using the updated mitigation scenario and different parameter scenarios compared against baseline mortality and PVA metrics for the FFC SPA population for Hornsea Three alone

Collision risk estimates	Parameter scenario		
	Applicant	Applicant's interpretation of Natural England's position	Examining Authority
Annual collision rate			
LCL	3	40-46	5-5
Mean	4	65-73	7-9
UCL	6	91-104	11-12
Increase in baseline mortality (%)			
LCL	0.02	0.31-0.35	0.04-0.04
Mean	0.03	0.50-0.57	0.06-0.07

Collision risk estimates	Parameter scenario		
	Applicant	Applicant's interpretation of Natural England's position	Examining Authority
UCL	0.05	0.70-0.80	0.08-0.09
PVA (Counterfactual of final population size (35 years))			
LCL	0.999	0.985-0.983	0.998-0.998
Mean	0.998	0.975-0.972	0.997-0.997
UCL	0.998	0.965-0.961	0.996-0.995
PVA (Counterfactual of growth rate)			
LCL	1.000	0.999-0.999	1.000-1.000
Mean	1.000	0.999-0.999	1.000-1.000
UCL	1.000	0.999-0.999	1.000-1.000

In-combination

3.6 Two in-combination totals were presented during the Hornsea Three examination, one value using collision risk estimates calculated using the Basic version of the model[2] for all projects considered in-combination and another value using collision risk estimates calculated using the Extended version of the model, where available, for projects considered in-combination. The two tables below present collision risk estimates and impact metrics using the in-combination totals calculated using the Basic model (Table 3.4) and the Extended model, where available for other projects (Table 3.5).

Table 3.4: In-combination collision risk estimates for kittiwake at FFC SPA using the **Basic model** for all projects compared against baseline mortality and PVA metrics for the FFC SPA population incorporating the updated mitigation scenario for Hornsea Three

Collision risk estimates	Parameter scenario		
	Applicant	Applicant's interpretation of Natural England's position	Examining Authority
In-combination impact from other projects (APP-065 and REP1-005)	250	250	250
Annual collision rate			
LCL	253	290-296	255-255
Mean	254	315-323	257-259
UCL	256	341-354	261-262
Increase in baseline mortality (%)			
LCL	1.94	2.23-2.27	1.96-1.96

[2] See Band (2012) for further information on the two models in the Band (2012) CRM.

Collision risk estimates	Parameter scenario		
	Applicant	Applicant's interpretation of Natural England's position	Examining Authority
Mean	1.96	2.42-2.49	1.98-1.99
UCL	1.97	2.63-2.73	2.00-2.02
PVA (Counterfactual of final population size (35 years))			
LCL	0.908	0.895-0.893	0.907-0.907
Mean	0.908	0.887-0.884	0.907-0.906
UCL	0.907	0.878-0.874	0.905-0.905
PVA (Counterfactual of growth rate)			
LCL	0.997	0.997-0.997	0.997-0.997
Mean	0.997	0.997-0.997	0.997-0.997
UCL	0.997	0.996-0.996	0.997-0.997

Table 3.5: In-combination collision risk estimates for kittiwake at FFC SPA using collision risk estimates calculated using the **Extended model**, where available compared against baseline mortality and PVA metrics for the FFC SPA population incorporating the updated mitigation scenario for Hornsea Three

Collision risk estimates	Parameter scenario		
	Applicant	Applicant's interpretation of Natural England's position	Examining Authority
In-combination impact from other projects (APP-065 and REP1-005)	107	107	107
Annual collision rate			
LCL	110	147-153	112-112
Mean	111	172-180	114-116
UCL	113	198-211	118-119
Increase in baseline mortality (%)			
LCL	0.84	1.13-1.17	0.86-0.86
Mean	0.86	1.32-1.39	0.88-0.89
UCL	0.87	1.53-1.63	0.90-0.92
PVA (Counterfactual of final population size (35 years))			
LCL	0.958	0.945-0.944	0.958-0.958
Mean	0.958	0.936-0.933	0.957-0.956
UCL	0.957	0.927-0.922	0.956-0.955
PVA (Counterfactual of growth rate)			
LCL	0.999	0.998-0.998	0.999-0.999

Collision risk estimates	Parameter scenario		
	Applicant	Applicant's interpretation of Natural England's position	Examining Authority
Mean	0.999	0.998-0.998	0.999-0.999
UCL	0.999	0.998-0.998	0.999-0.999

4. Discussion

Comparison

4.1 The collision risk predictions for the updated mitigation scenario (for Hornsea Three alone) are compared to those presented in Examination for the 33.17 m and 37.5 m lower rotor blade tip height as presented in Sections 5 and 6, respectively, in REP7-031 and Table 3.3 and Table 3.4, respectively, in REP9-047 for each set of modelling assumptions presented in Table 2.1. For the Applicant's position, the updated mitigation scenario results in a 40.9% or 21.2% reduction in collision risk to the FFC SPA population of kittiwake when comparing with the 33.17 m and 37.5 m lower rotor tip height scenarios respectively, with a similar magnitude of reduction estimated when using the parameters requested by the Examining Authority. When using Natural England's position, the resulting collision risk estimates calculated when using the updated mitigation scenario represent a 59.4% and 38.4% reduction when compared to those collision risk estimates calculated during examination for the 33.17 m and 37.5 m lower rotor tip height scenarios, respectively.

Table 4.1: Comparison between collision risk estimates for kittiwake at FFC SPA

		Parameter scenario		
		Applicant	Applicant's interpretation of Natural England's position	Examining Authority
Collision risk estimate apportioned to FFC SPA (upper and lower confidence intervals) for Hornsea Three alone	Examination (33.17 m MSL lower rotor height)	7 (4-10)	181 (112-257)	13-15 (8-9 to 18-21)
	Examination (37.5 m MSL lower rotor height)	5 (3-7)	119 (74-169)	10-11 (6-7 to 14-16)
	Updated mitigation scenario	4 (3-6)	65-73 (40-46 to 91-104)	7-9 (5-5 to 11-12)
% reduction (33.17 m lower rotor height to updated mitigation scenario)		**40.9**	**59.4**	**41.4**
% reduction (37.5 m lower rotor height to updated mitigation scenario)		21.2	38.4	21.9

5. Conclusion

5.1 When applying the Applicant's position, the collision rate is now reduced to 4 collisions/annum alone and 111 in-combination. When applying the Applicant's interpretation of Natural England's position, the collision rate is reduced to 65-73 collisions/annum alone and 315-323 in-combination. When applying those parameters requested by the Examining Authority, the collision rate is 7-9 collisions/ annum and either 257-259 in-combination (if applying the Basic version of the Band 2012 CRM to all other projects) or 114-116 (if applying the Extended version of the CRM where available for other projects)[3].

5.2 The differences between the three positions presented above are due to the different parameter assumptions as set out in Table 2.1. Of the three sets of parameters those of the Applicant and the Examining Authority provide the most similar appraisal of collision risk for the kittiwake population at FFC SPA. This is due to alignment in those parameters that have the largest effect on collision risk estimates namely Band model Option, and breeding season apportioning rate.

5.3 The Applicant has maintained throughout the Application and Examination, specifically when considering mitigation measures that there would be no adverse effect on the integrity of the kittiwake population at FFC SPA as a result of collision impacts from Hornsea Three alone or in-combination with other plans and projects. The updated mitigation scenario considered in this report is without prejudice commitment by Hornsea Three to reduce impacts on the kittiwake feature at FFC SPA despite the Applicant's previous conclusions of no AEOI on the FFC SPA.

5.4 The Applicant therefore continues to maintain its conclusion that these collision rates are of insufficient magnitude to lead to an AEOI of the kittiwake feature of the FFC SPA. It should be noted that the in-combination collision rate for the Applicant's interpretation of Natural England's position (which is considered to be unnecessarily precautionary, (Appendix 1, Part 2 to Applicant's Response) is lower than or comparable to that approved by the Secretary of State for East Anglia THREE and Hornsea Project Two.

[3] The Examining Authority did not request in-combination totals as part of PD-020 and therefore such totals were not presented in REP9-047. In-combination totals calculated when using both the Basic and, where available, Extended versions of the Band CRM are therefore presented here.

6. References

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Application/Examination submissions

APP-051 - Ørsted Hornsea Project Three (UK) Ltd. 5.2 Report to inform Appropriate Assessment

APP-054 - Ørsted Hornsea Project Three (UK) Ltd. 5.2.3 RIAA Annex 3 - Phenology, Connectivity and Apportioning

APP-065 - Orsted Hornsea Project Three (UK) Ltd. 6.2.5 ES Volume 2 - Ch 5 - Offshore Ornithology

APP-109 - Ørsted Hornsea Project Three (UK) Ltd. 6.5.5.3 ES Volume 5 - 5.3 - Collision Risk Modelling

REP1-005 - Ørsted Hornsea Project Three (UK) Ltd. Appendix 49 – Applicants Response to the Examining Authority's Written Questions

REP1-211 - Natural England. Annex C: Natural England Detailed Advice on Ornithology

REP6-042 - Ørsted Hornsea Project Three (UK) Ltd. Appendix 28 - Position of the Applicant in relation to collision
risk modelling

REP6-043 - Ørsted Hornsea Project Three (UK) Ltd. Appendix 29 - Applicants interpretation of Natural England's
position in relation to collision risk modelling

REP7-030 - Ørsted Hornsea Project Three (UK) Ltd. Appendix 12 - Position Statement on Ornithology Mitigation
Options

REP7-031 - Ørsted Hornsea Project Three (UK) Ltd. Appendix 13 - Collision Risk Estimates for Mitigation Scenarios

REP9-047 - Ørsted Hornsea Project Three (UK) Ltd. Appendix 19 - Response to Examining Authority's FQ3.1 Rule 17
Collision Risk Modelling

PD-020 - Rule 17 - 19 March 2019 Request for further information to Ørsted Hornsea Project Three (UK) Ltd

Appendix A Response to Natural England's comments on Hornsea Project Three Ornithology Baseline Data Comparison

6.1 Natural England have provided comments on the Applicant's post-examination submission in relation to supplemental ornithological data submitted to validate the Applicant's baseline data provided in its ES. The following section provides responses to comments provided by Natural England.

6.2 In summary, the report was provided to confirm that the baseline dataset used as part of the Hornsea Three application captured the variability present in seabird populations present at Hornsea Three. It was not provided with the intention of re-running the assessments presented in the EIA/RIAA. The comparisons presented indicated that any differences were not significant in assessment terms. The report was therefore able to confirm the conclusions drawn in the EIA and RIAA in relation to limited variability in the abundance of each species and relative lower importance of these months when compared to the abundance recorded in breeding months, for example.

Table 6.1: Responses to Natural England's comments on the Applicant's post-examination submission.

Natural England comment	Applicant's response
Whilst this additional survey effort may go at least some way to addressing concerns outlined by Natural England in the Examination, there remains only one December count, which will affect both displacement and collision estimates.	The Applicant welcomes Natural England's acknowledgement that the supplemental survey data is helpful and that it addresses their concerns to some degree. Additional surveys were conducted in January, February (two surveys) and March 2019. It is often the case when conducting baseline surveys to conduct multiple surveys in a single month if a survey has been missed in other months due to operational reasons (e.g. adverse weather conditions). As it was not possible to conduct a survey in December 2018 an additional survey was conducted in February.
From the information provided within the report it is not possible to evaluate the impact of the Hornsea Three project in light of the new data collected.	The intention of the report was not to provide an assessment of the impacts of Hornsea Three based on the additional data collected, rather the report was produced to provide support for the assessments already conducted, showing that additional baseline data would not alter these conclusions.
The report does not provide full details of the additional data collected (abundance and density numbers), including information on the precision and confidence intervals of the individual survey estimates. Some information is presented in graphs, but actual figures needed for the assessments are not presented.	The information presented in the report is sufficient to address the objectives of the report, namely to confirm the conclusions reached in the assessments presented in the EIA/RIAA and during the examination. It was not the intention of the Applicant to provide an assessment based upon the additional survey data (paragraph 2.1.5 of the report).

Natural England comment	Applicant's response
The parameters used in the assessments are unclear and do not seem to read across to those provided in examination.	The parameters used in the analyses are presented in Appendix 1 alongside the PINS document reference number from which the parameters were taken, and are consistent with those used in the Examination.
The turbine parameters/hub height considered within the assessment are not consistent with those presented in the application and appear to fall outside the Rochdale envelope. Although the Applicant presented different turbine parameters in the examination (e.g. REP7-030), Natural England's understanding) was that these were indicative and not representative of any firm commitment from the project team and as such were not in the draft DCO. Consequently the assessment presented in this report would not be representative of the project parameters defined in the application.	The report presents collision risk estimates using all three of the lower rotor tip height scenarios considered during the examination (33.17 m, 37.5 m and 40 m). The 33.17 m scenario was that used in the application as defined in Table 1.4 of APP-109 and represented the maximum design scenario (or worst case) at point of Application. During the examination the Applicant explored the implications of increasing the minimum rotor tip height to 37.5 m if such a mitigation step was deemed necessary by any party to reduce impacts on ornithological receptors and therefore reach a conclusion of no adverse effect. These mitigation options are *inside* the Rochdale Envelope: they reflected reductions from the maximum design scenario (for lower blade tip), which reduced collision impacts, and did not go beyond any other maximum parameter (e.g. maximum tip height) or lead to any other changes to assessments.
Throughout the examination, Natural England provided a number of comments in relation to the methodology and parameters used in the assessment of collision and displacement. These outstanding issues have not been given any consideration in the updated assessments provided in this report. These would need to be resolved before Natural England could have confidence in the outputs or any conclusions drawn from them.	The analyses presented in the report representing the Applicant's interpretation of Natural England's position are based on the comments of Natural England as provided in REP1-211 and summarised in REP6-043 for CRM. With the exception of comments on sufficiency of the baseline data, the Applicant is not aware of any further issues Natural England have in regard to the parameters used for CRM or displacement analysis in their submission at Deadline 7.
Consequently, should the Applicant wish to undertake updates to this latest assessment, we would advise that the parameters of the assessment would need to be agreed with Natural England. This would require discussions akin to those held within a typical evidence plan process, which would be challenging in the current timescales.	As noted above the purpose of the report was to validate the assessments already conducted, by showing variability had been captured, in order to demonstrate that additional baseline data would not be expected to materially alter these conclusions.

Natural England comment	Applicant's response
The additional data has resulted in an increase in the predicted impacts for some species compared to the original assessment;	This statement is correct for three species, however, increases in collision risk estimates only occur when applying Natural England's parameter assumptions for: b. Kittiwake – 2 collisions/annum c. Lesser black-backed gull - 1 collision/annum d. Great black-backed gull – 1 collision/annum When set against the context of relevant populations these increases would be considered immaterial in assessment terms. Increases have also occurred for displacement mortality of some species however, such changes are also immaterial in assessment terms.
The reassessments only consider the mean values and not the range of values as Natural England advises, and as the precision of the data is poor, the confidence intervals (range) around the mean values is wide;	The precision of the additional data has not been presented, however, the surveys conducted have used a standard methodology applied at numerous offshore wind farms (including Hornsea Three)
The assessment is based on a comparison of Hornsea Three's original figures, which Natural England do not agree with, and there is limited detail on how this assessment has been undertaken;	The report does not provide an assessment of any collision risk estimates or displacement mortality, it simply compares the baseline data used in the application against those values obtained from additional surveys. The report calculates effects (collision risk and displacement mortality) but does not consider these against relevant populations or use PVA modelling to conduct an assessment, as would be done in an EIA or RIAA.

Annex C: Export Cable Protection Assessment for Marine Protected Areas

Hornsea Project Three
Offshore Wind Farm

Hornsea Project Three

Offshore Wind Farm

Response to the Secretary of State's Consultation
Appendix 4 Annex C: Export Cable Protection Assessment for Marine Protected Areas

Date: February 2020

Response to the Secretary of State's Consultation

Appendix 4 Annex C: Export Cable Protection Assessment for Marine Protected Areas

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5 Howick Place,

London, SW1P 1WG

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1. Introduction

Purpose

1.1 In her letter dated 27 September 2019, the Secretary of State (SoS) requested further consultation on the impacts of cable protection on protected seabed features of the Wash and North Norfolk Coast (WNNC) Special Area of Conservation (SAC), the North Norfolk Sandbanks and Saturn Reef (NNSSR) SAC and the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ). Although the Applicant remains confident of its position (of no AEOI on integrity of SACs and no significant risk of hindering achievement of conservation objectives of the MCZ) on the basis of the maximum design scenario (MDS) as set out during Examination, the Applicant has taken the opportunity afforded by the Consultation to vigorously re-appraise all elements of the MDS for Hornsea Three, in order to ensure all feasible mitigation has been deployed.

1.2 This report investigates the potential for Hornsea Three to lessen its impact on the designated sites through further detailed engineering design optimisation. Specifically, it focuses on the potential for further reduction of secondary cable protection[1] within the marine protected areas which coincide with the offshore cable corridor. This report therefore focusses on the feasibility of remedial cable installation works in the event that the target burial depths are not achieved during the initial trenching campaign, as an alternative to deployment of cable protection.

1.3 The Preliminary Trenching Assessment submitted in Examination (REP6-026) was previously completed for the marine protected areas potentially impacted. The previous assessment provided a detailed assessment of the soil units, presenting a ground model within the Cromer Shoal Chalk Beds MCZ[2] and the Wash and North Norfolk Coast SAC and the North Norfolk Sandbanks and Saturn Reef SAC. Further to the geological assessment a review of the preferred cable installation tools was also provided as part of the Preliminary Trenching Assessment. This report expands on the results of the ground model presented to refine (where possible) the 10% maximum percentage of secondary cable protection which may be required for export cables within these marine protected areas.

Site Overview

1.4 The proposed offshore cable corridor for Hornsea Three is illustrated in Figure 1.1. The offshore cable corridor is approximately 156.5 km long and enters the Hornsea Three array area at approximately Kilometre Point (KP) 151.200. The offshore cable corridor then makes landfall just west of Weybourne on the North Norfolk coast.

[1] Secondary cable protection is considered protection to the cable after remedial works have been undertaken and may include rock placement.
[2] Note the Applicant has committed to removing all infrastructure from Markham's Triangle MCZ (see Appendix 4 to the Applicant's Response to the SoS).

1.5 There are three marine protected areas along the Hornsea Three offshore cable corridor;

- Cromer Shoal Chalk Beds MCZ;
- The Wash and North Norfolk Coast SAC; and
- The North Norfolk Sandbanks and Saturn Reef SAC.

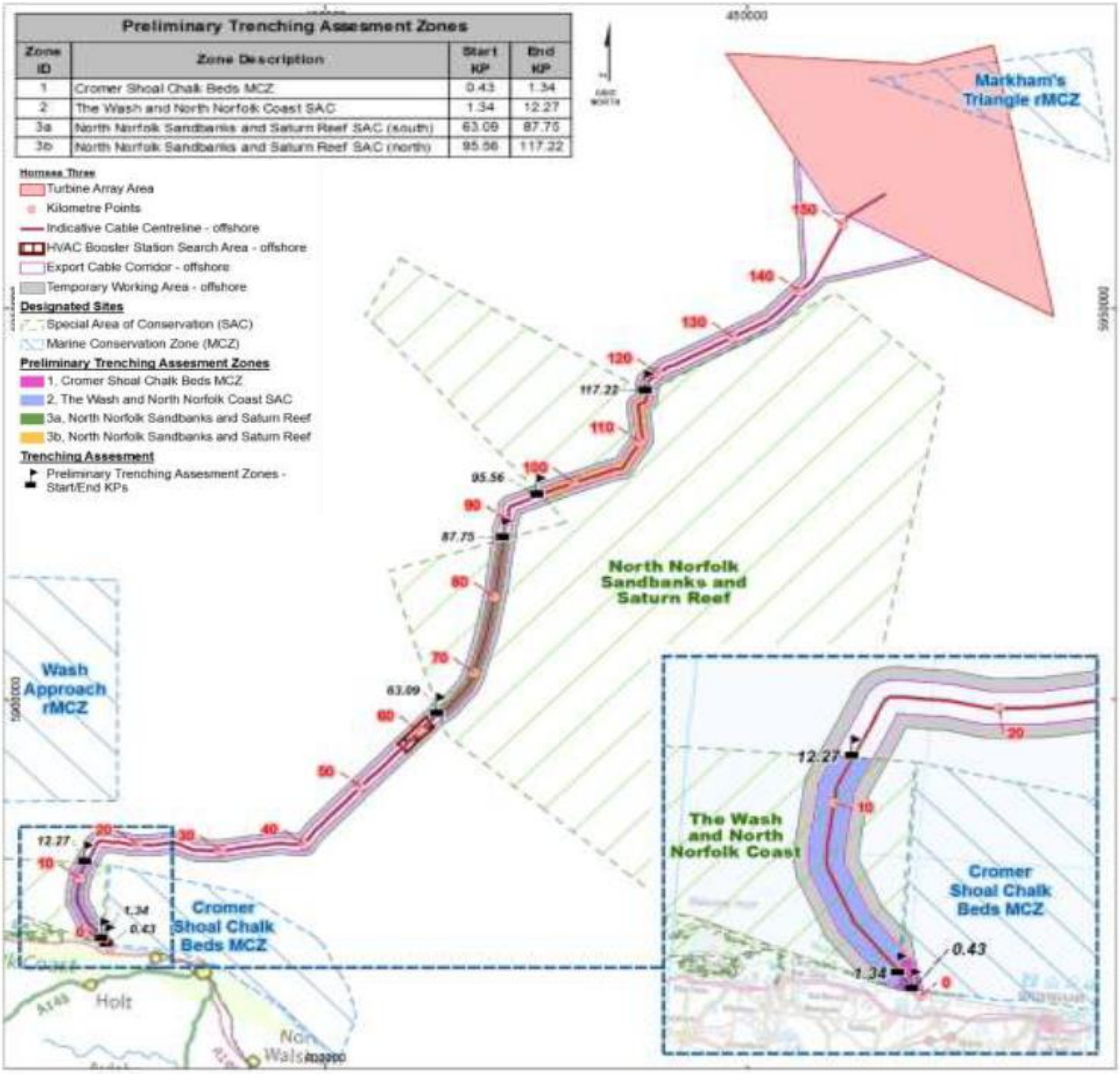


Figure 1.1: Hornsea Three Offshore Cable Corridor; marine protected areas highlighted

1.6 Reference KP's along the cable corridor are provided in Table 1.1, for clarity. It should be noted that KP's are referenced to the cable corridor centreline.

Table 1.1: Marine Protected areas by KP

Zone ID	Zone Description	KP start	KP End
1	Cromer Shoal Chalk Beds MCZ	0.43	1.34
2	The Wash and North Norfolk Coast SAC	1.34	12.27
3a	North Norfolk Sandbanks and Saturn Reef SAC (south)	63.09	87.75
3b	North Norfolk Sandbanks and Saturn Reef SAC (north)	95.56	117.22

2. Assessment Methodology Overview

2.1 This assessment provides a methodology for the calculation of secondary cable protection required along the export cables for Hornsea Three based on the Applicant's confidence of achieving the Target Depth of Lowering (TDoL).

2.2 During the initial trenching campaign there are several factors which are outside the control of the Applicant which can lead to reduced burial such as:

- Adverse weather conditions;
- Mechanical breakdown of the trencher; and
- Unforeseen soil conditions.

2.3 Based on the Applicants experience of installing export cables, in similar soil conditions to those encountered at Hornsea Three, a conservative estimate of areas that may not meet the TDoL is 10% of the length of export cables was assumed for the purposes of the consent application. In practice, when a cable does not meet the TDoL required, there are a number of options available prior to the specification of cable protection as a risk mitigation measure. Some of these options are:

- Assessment of the as-built survey data to understand if an acceptable burial depth has been achieved and therefore the cable can be considered protected from the natural and anthropogenic hazards [3];
- Assess the likelihood of natural reinstatement and therefore possible additional sediment cover on top of the cable which provides further protection; and
- Assess the ground conditions and as-built data and therefore the suitability of the cable to remedial burial.

2.4 The focus of this assessment will be on the final option and suitability of the soils within the marine protected areas for remedial burial, to reduce the requirement for cable protection in these areas.

[3] It should be noted that the TDoL defined during installation do not always reflect the minimum acceptable burial depths that will be accepted from a risk perspective as TDoL are defined based on additional factors, such as the tool being used, where it may be optimal to target deeper depths than the minimum acceptable burial depth due to the configuration of the tool (i.e. plough share depths / jet sword lengths).

2.5 As was detailed in the Preliminary Trenching Assessment (REP6-026), the Applicant has commissioned several geophysical and geotechnical site investigation campaigns within the marine protected areas and therefore have a detailed understanding of the site conditions. Utilising this knowledge, it is possible to predict the suitability of the soils to remedial burial operations in the event that the TDoL is not achieved in the initial trenching campaign.

2.6 Route maps indicating the expected soil conditions based on the interpreted geophysics and characterised soils have been developed and are presented in Appendix A- Assessment of soil provinces. These developed maps provide an overview of soil distribution along the cable route within the depth of interest (this has been taken as 2 m below seabed level). The site has been zoned into the following soil provinces (brackets indicates how data is illustrated in Appendix A- Assessment of soil provinces):

- Less than 2 m Bligh Bank cover overlying Bolders Bank (HLC <2 m over Bolders Bank);
- Less than 2 m Bligh Bank cover overlying Chalk (HLC <2 m over Chalk);
- Bligh Bank (HLC) to Full Trench Depth;
- Chalk to the full trench depth;
- Less the 2 m Bligh Bank cover overlying Botney Cut (HLC <2 m over Botney Cut);
- Less than 2 m Botney Cut cover over Bolders Bank (HLC < 2 m over Bolders Bank);
- Less than 2 m Botney Cut cover over Chalk (HLC < 2 m over Chalk);
- Bolders Bank to Full Trench Depth;
- Less than 2 m Bligh Bank cover overlying Egmond Ground (HLC <2 m over Egmond Ground);
- Less than 2 m Bligh Bank cover overlying Swarte Bank (HLC <2 m over Swarte Bank);
- Egmond Ground to Full Trench Depth; and
- Botney Cut at Full Trench Depth.

2.7 As noted above, levels of likelihood for achieving TDoL have been developed based on soil characteristics within each soil province. From the developed soil provinces, a low, medium or high likelihood of completing remedial trenching is defined (details of how these levels of likelihood are determined is discussed in Section 4).

2.8 Based on the developed levels of likelihood, remedial trenching heat maps have been generated for the soil provinces within each zone (Appendix B- Heat Maps). The required percentage of cable protection in each of the three marine protected areas has been calculated based on the developed heat maps; results are outlined in Section 5. Additionally, a step-by-step process for the calculation undertaken is also outlined.

3. Overview of soil parameters

3.1 Soils along the cable route have previously been characterised based on geotechnical survey data collected. A summary of the characteristic shallow soil properties for each of the soil units within each soil province identified along the export cable is outlined in Table 3.1. The summary table below is referenced from the Preliminary Trenching Assessment.

Table 3.1: Description of soil parameters

Formation	Description	Particle Size Distribution			Relative Density (%)	Undrained Shear Strength (kPa)
		Clay/Slit (%)	Fine to Medium sand (%)	Course sand to gravel (%)		
Bligh Bank	Fine to medium sand	<5	60 to 80	<5 to 20	20 to 80	NA
Botney Cut (BTC)	Interbedded sandy, gravelly medium dense silts and soft to firm clay	< 5 to 25	50 to 80	<10	10 to 40	10 to 65
Boulders Bank (BBF)	Stiff to very stiff clay, locally sandy and gravelly	25 to 50	20 to 30	20 to 30	NA	100 to 150 (locally 50)
Egmond Ground (EGF)	Dense to very dense sand	<5 to 20	60 to 90	<5	80 to 100	NA
Swarte Bank (SBF)	Stiff to hard clay	20 to 50	20 to 30	10 to 15	NA	150 to 250
Chalk	Weathered structureless Chalk	NA	NA	NA	NA	100 locally up to 500

4. Levels of Likelihood for achieving TDoL

4.1 Levels of likelihood for remedial burial have been developed (Table 4.1) based on the expected soil conditions within each of the marine protected areas and the Applicants experience of cable installation remedial works in similar ground conditions. Remedial works in this case refers to jet trenching with tracked jet trenchers, controlled flow excavation (CFE) or similar tools.

4.2 The level of likelihood of successful remedial burial assigned to each soil unit is outlined in Table 4.2. For clarity the overall likelihood level of achieving TDoL should be understood as the baseline 90% plus 0%, 5% or 8% depending on the soil (i.e. soils with a high likelihood of success will have a reduced requirement for secondary cable protection; see Table 4.1).

Table 4.1: Levels used to assess likelihood of remedial burial

Definition	Description in relation to cable burial	Estimated length where Cable Protection may be required (%)
Low likelihood of success	The cable is unlikely to reach the TDoL based on the expected soil conditions. Any remedial works may take multiple passes or show limited improvement in burial with additional passes.	10
Moderate likelihood of success	The cable is likely to reach the TDoL in some sections of the cable route although more than one pass will likely be required.	5
High likelihood of success	The cable is likely to reach the TDoL and the risk to the cable is considered low. Burial will most likely be achieved in one jetting pass.	2

Table 4.2: Trenching likelihood values

Formation	Description	Likelihood Level of successful remedial trenching	Overall Likelihood Level of achieving TDoL in soil unit (%)	Maximum Cable Protection required in soil unit (%)
Bligh Bank	Fine to medium sand	High	98	2
Botney Cut (BTC)	Interbedded sandy, gravelly medium dense silts and soft to firm clay	Medium	95	5
Boulders Bank (BBF)	Stiff to very stiff clay, locally sandy and gravelly	Low	90	10
Egmond Ground (EGF)	Dense to very dense sand	High	98	2
Swarte Bank (SBF)	Stiff to hard clay	Low	90	10
Chalk	Weathered structureless Chalk	Medium	95	5

4.3 From the presented figures in Table 4.2, it is seen that the likelihood to complete remedial trenching operations to achieve the TDoL is sensitive to the soil composition. The following justification has been applied to the assignation of trenching likelihood:

- Bligh Bank (HLC)
  - Granular material and soils considered suitable to jet trenching
- Botney Cut (BTC)
  - Anticipated to be predominantly granular material with a higher gravel content. Where clays are present, they are described as in the range of soft to firm, which is considered feasible for jet trenching
- Bolders Bank (BBF)
  - Described as stiff to very stiff clay and unlikely to be suitable for jet trenching
- Egmond Ground (EGF)
  - Anticipated to be predominantly dense to very dense granular material suitable for jet trenching
- Swarte Bank (SBF)
  - Described as stiff to hard clay and unlikely to be suitable for jet trenching
- Chalk
  - Experience in chalk shows that construction of a trench to the TDoL is viable; however, chalk nodules, gravels and flint in certain cases can settle in the bottom of the trench reducing the burial depth during the initial trenching campaign. The Applicant's experience has shown that additional burial can be achieved by fluidising this material during remedial burial operations.

4.4 Based on the developed levels set out in Table 4.1, heat maps have been produced for the three marine protected areas indicating the related likelihood of remedial burial (Appendix B- Heat Maps). The developed heat maps compare directly with the interpreted soils (Appendix A- Assessment of soil provinces). It should be noted that for the completed analysis and associated generated maps, the TDoL is assumed to be 2 m below seabed. Further to this, the analysis output is calculated based on the lowest likelihood of the soil types encountered over the assumed trench depth at a given location e.g. If Bligh Bank overlies Boulders Bank the likelihood is low, additionally if Bolders Bank overlies chalk the likelihood is low. This assumption is considered conservative but reasonable for the assessment at this stage of the project.

4.5 Based on the developed likelihood levels and heat maps the amount of secondary protection required in each section has been calculated. The calculation of the overall percentage in each section along with a bullet pointed calculation process is outlined in Section 5.

5. Calculated Secondary Cable Protection Requirements

5.1 Based on the outlined likelihood levels and heat maps, analysis has been completed to revise the previously maximum design scenario or up to 10% of the length of export cables potentially requiring cable protection in the marine protected areas. The analysis undertaken to establish the new secondary protection requirements is based on the occurrence of each soil province within the marine protected areas. The ratio of the area of a given likelihood level (based on the identified soils) relative to the total surveyed area is used to establish the likelihood of meeting the TDoL.

5.2 The calculation to establish the required amount of secondary protection is outlined as a step-by-step process below;

- Area of high/ medium/ low likelihood soil provinces in protected areas divided by the total surveyed area of SAC (associated to cable route)
- Length of cables through protected areas multiplied by (1) (separately low, medium and high likelihood)
- Maximum secondary protection requirement for associated likelihood (indicated in Table 4.2) multiplied by (2)
- Sum the results of (3) to get the total secondary protection required in a given area.

5.3 It should be noted that sections are sub-divided where required to provide the most accurate results for this analysis i.e. where the available interpreted data width ranges over a given section.

5.4 Based on the outlined calculation methodology the revised secondary protection requirements for the marine protected areas are outlined in Table 5.1.

Table 5.1: Revised Cable Protection Requirements within marine protected areas along offshore cable corridor

Zone ID	Zone Description	Maximum Secondary Protection required (%)
1	Cromer Shoal Chalk Beds MCZ	7.0
2	The Wash and North Norfolk Coast SAC	6.0
3	North Norfolk Sandbanks and Saturn Reef SAC	6.0

6. Implications for Marine Protected Ares

6.1 Based on the reductions to the project design envelope assumptions for cable protection, Table 6.1 below sets out the updated maximum volumes and areas of cable protection within the three marine protected areas coinciding with the offshore cable corridor. These will be set out in the Outline Cable Specification and Installation Plan (Appendix 6 to Applicant's Response).

6.2 The implications of this reduction in the maximum cable protection in Cromer Shoal Chalk Beds MCZ have been considered within the updated MCZ Assessment (Appendix 5 to Applicant's Response) and summarised below .

6.3 The implications of this reduction in the maximum cable protection requirements which could be placed within the SACs (i.e. proportions of Annex I features and sub-features affected) are as follows:

- For the **North Norfolk Sandbanks and Saturn Reef SAC**, the maximum area affected by placement of cable protection is 418,440 m^2, which represents 0.01% of the total area of the Annex I sandbanks feature of the SAC (previously 497,400 m^2 or 0.01 % of the total area of the Annex I sandbanks feature).
- For the **Wash and North Norfolk Coast SAC** the maximum area affected is 27,720 m^2, which represents 0.0026% of the total area of the Annex I sandbanks feature of the SAC (previously 46,200 m^2 or 0.004% of the total area of the Annex I sandbanks feature).
- For the sub-features of the Annex I sandbanks feature of the Wash and North Norfolk Coast SAC, as a worst case, it can be assumed that all cable protection will be placed entirely within either one of the three sub-features coinciding with the Hornsea Three offshore cable corridor, and therefore these areas/proportions are not additive. As noted in REP3-024, this is a conservative assumption, as Subtidal Coarse Sediments and Subtidal Mixed Sediments comprise a relatively short proportion of the length of the offshore cable corridor within this SAC. Notwithstanding this conservative assumption, the proportions of the sub-features affected are as follows:
  - Subtidal Sand: 0.0048% of the total area of this sub-feature would be affected in a maximum design scenario;
  - Subtidal Coarse Sediment: 0.077% of the total area of this sub-feature would be affected in a maximum design scenario; and
  - Subtidal Mixed Sediment: 0.0036% of the total area of this sub-feature would be affected in a maximum design scenario.
- For the Subtidal Sand feature of the Cromer Shoal Chalk Beds MCZ, the maximum area affected is 2,940 m^2, which represents 0.016% of the total area of this feature of the MCZ (or 0.0009% of the total area of the MCZ).

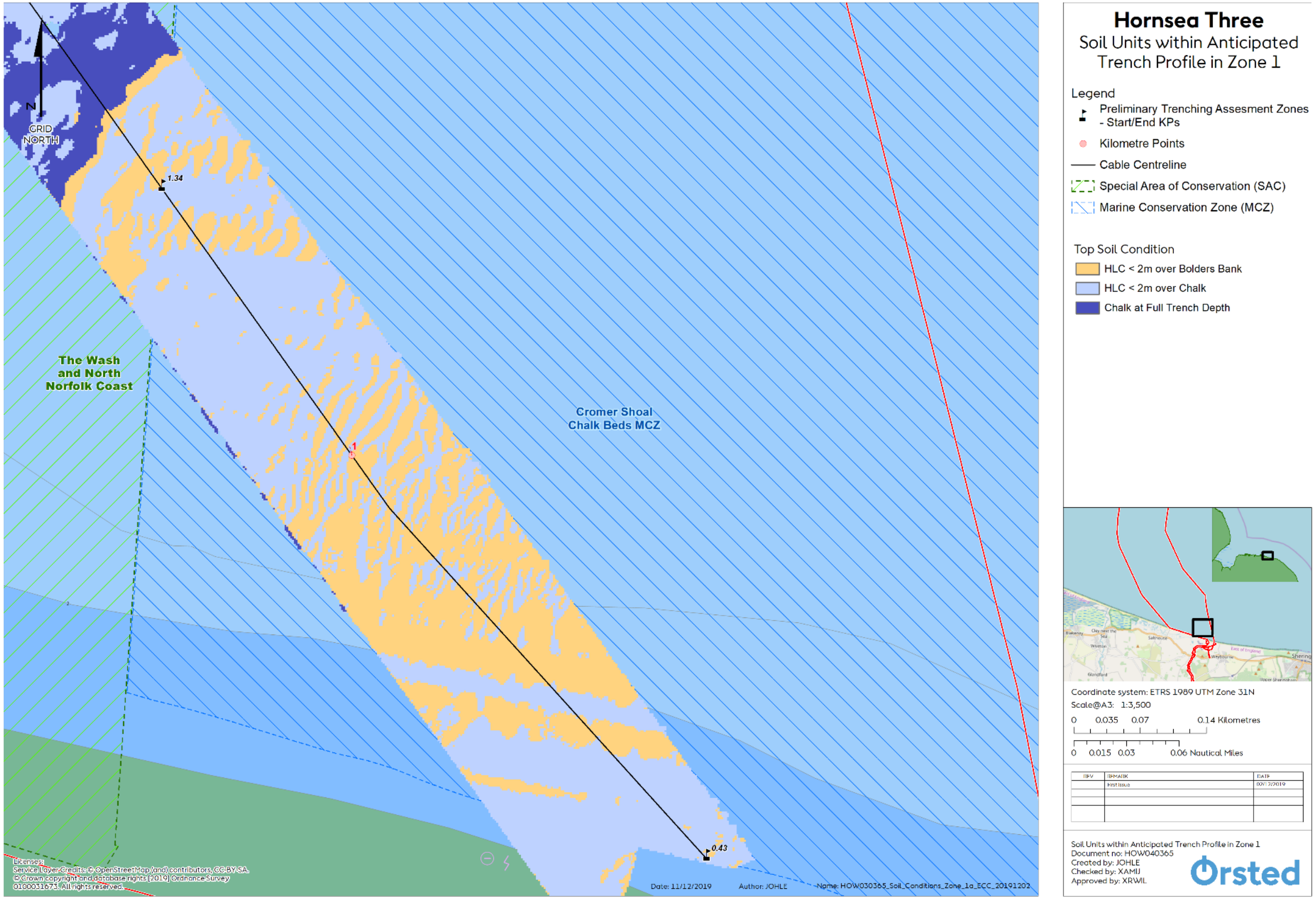
6.4 As these changes in the maximum design scenario for cable protection have resulted in reductions in the proportions of Annex I features and sub-features affected by cable protection from Hornsea Three, this does not change the overall conclusions of the Report to Inform Appropriate Assessment (APP-051), i.e. that Hornsea Three will not result in an adverse effect on integrity of either the North Norfolk Sandbanks and Saturn Reef SAC or the Wash and North Norfolk Coast SAC.

Table 6.1: Maximum design scenario for cable protection footprint and volumes within marine protected areas coinciding with the Hornsea Three offshore cable corridor.[4]

Designated Sites		Cable protection area (m^2)		Cable protection volume (m^3)	
		Refined Area	Previous Area	Refined Volume	Previous Volume
Cromer Shoal Chalk Beds MCZ	Total	2,940	4,200	5,250	6,000
North Norfolk Sandbanks and Saturn Reef SAC	Remedial protection	118,440	197,400	211,500	282,000
	Crossings	Unchanged	300,000	Unchanged	315,000
	Total	418,440	497,400	526,500	597,000
Wash and North Norfolk Coast SAC	Total	27,720	46,200	49,500	66,000

[4] Cable protection volume includes replenishment of cable protection which was laid during the construction phase, up to a maximum of 25% of the maximum volume assumed.

Appendix A Assessment of soil provinces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Kilometre Points
Cable Centreline
Special Area of Conservation (SAC)
Marine Conservation Zone (MCZ)
Top Soil Condition
HLC < 2m over Bolders Bank
HLC < 2m over Chalk
Chalk at Full Trench Depth
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1.34
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0.43
The Wash and North Norfolk Coast
Cromer Shoal Chalk Beds MCZ
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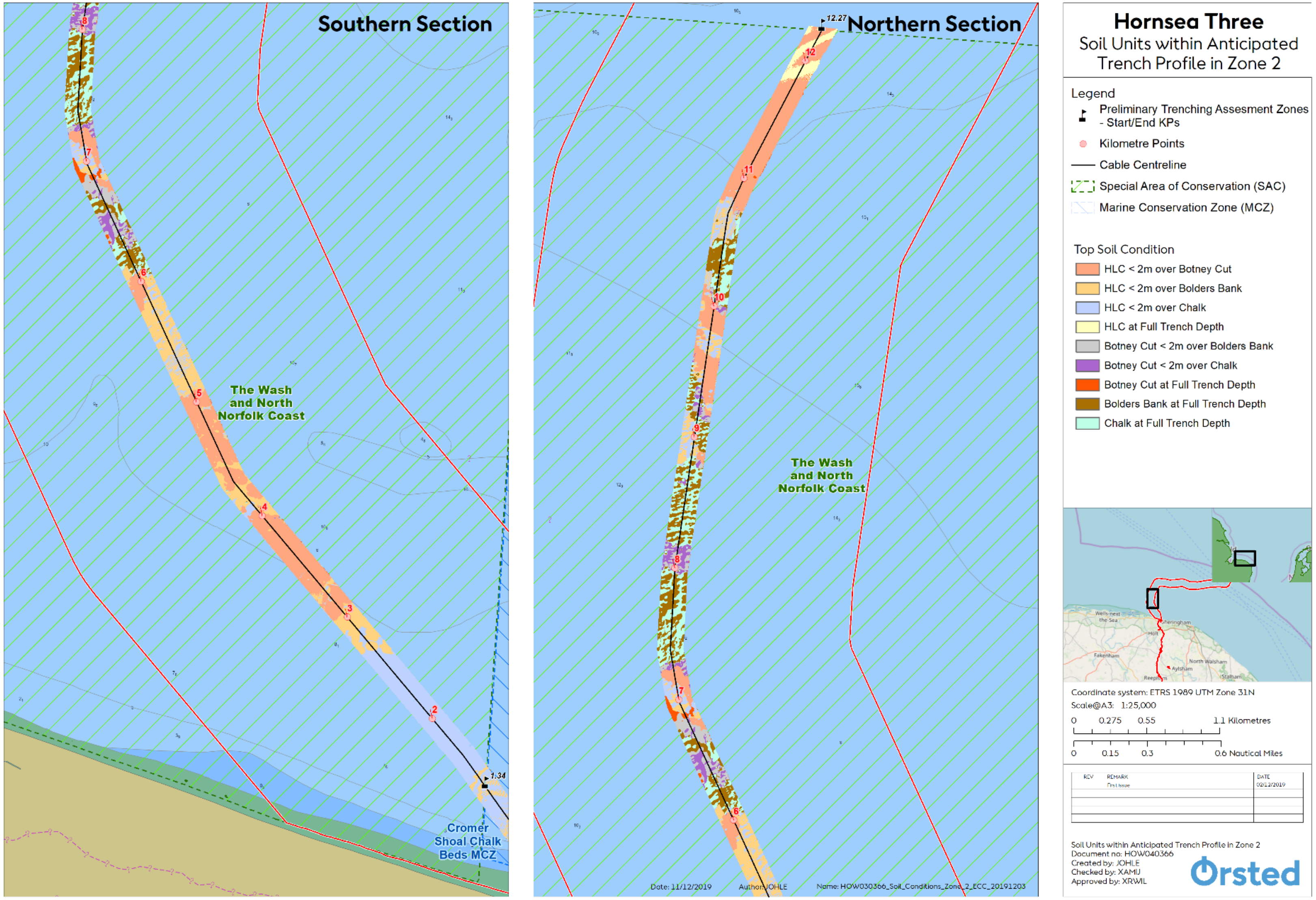
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Marine Conservation Zone (MCZ)
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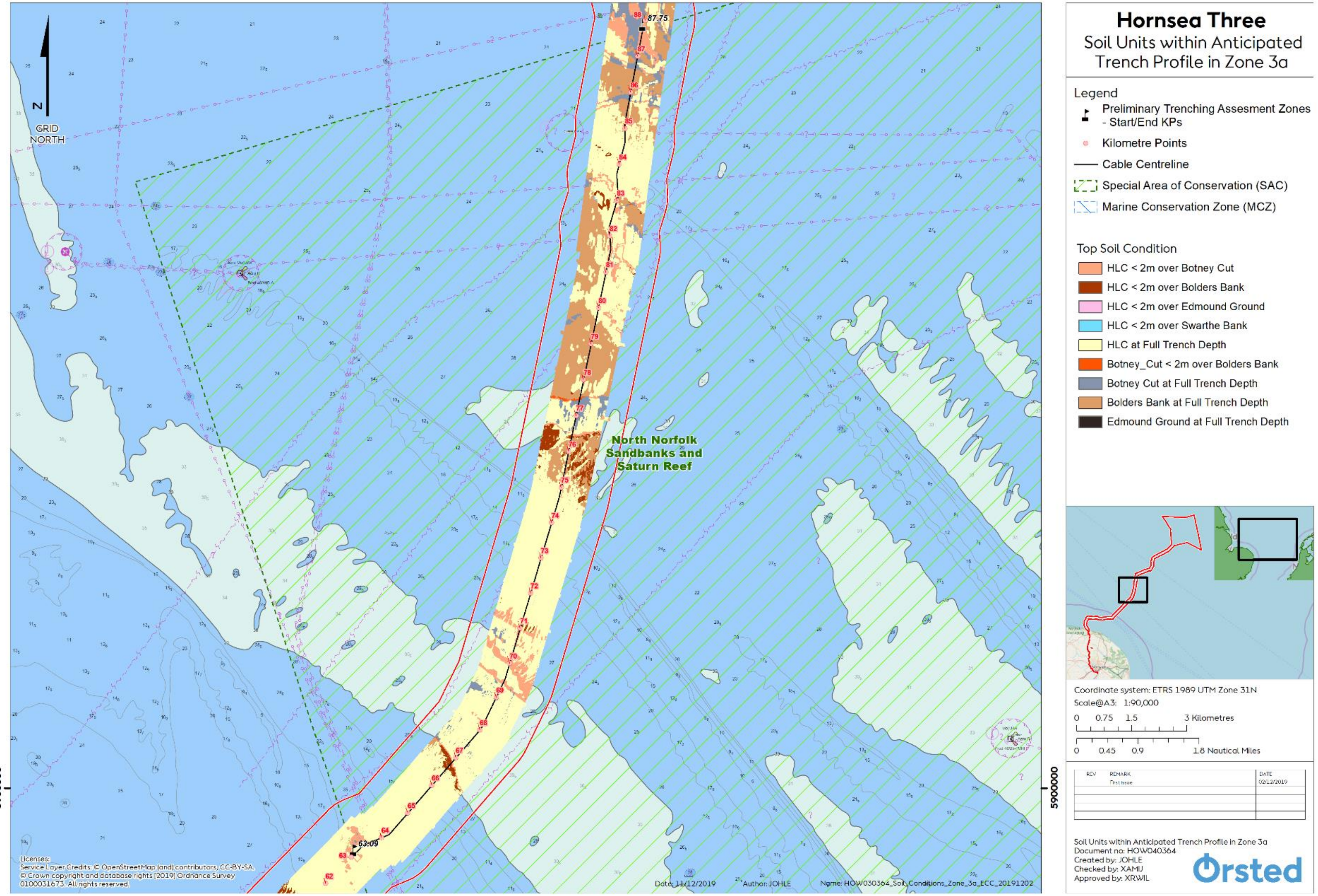
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Marine Conservation Zone (MCZ)
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HLC < 2m over Edmound Ground
HLC < 2m over Swarthe Bank
HLC at Full Trench Depth
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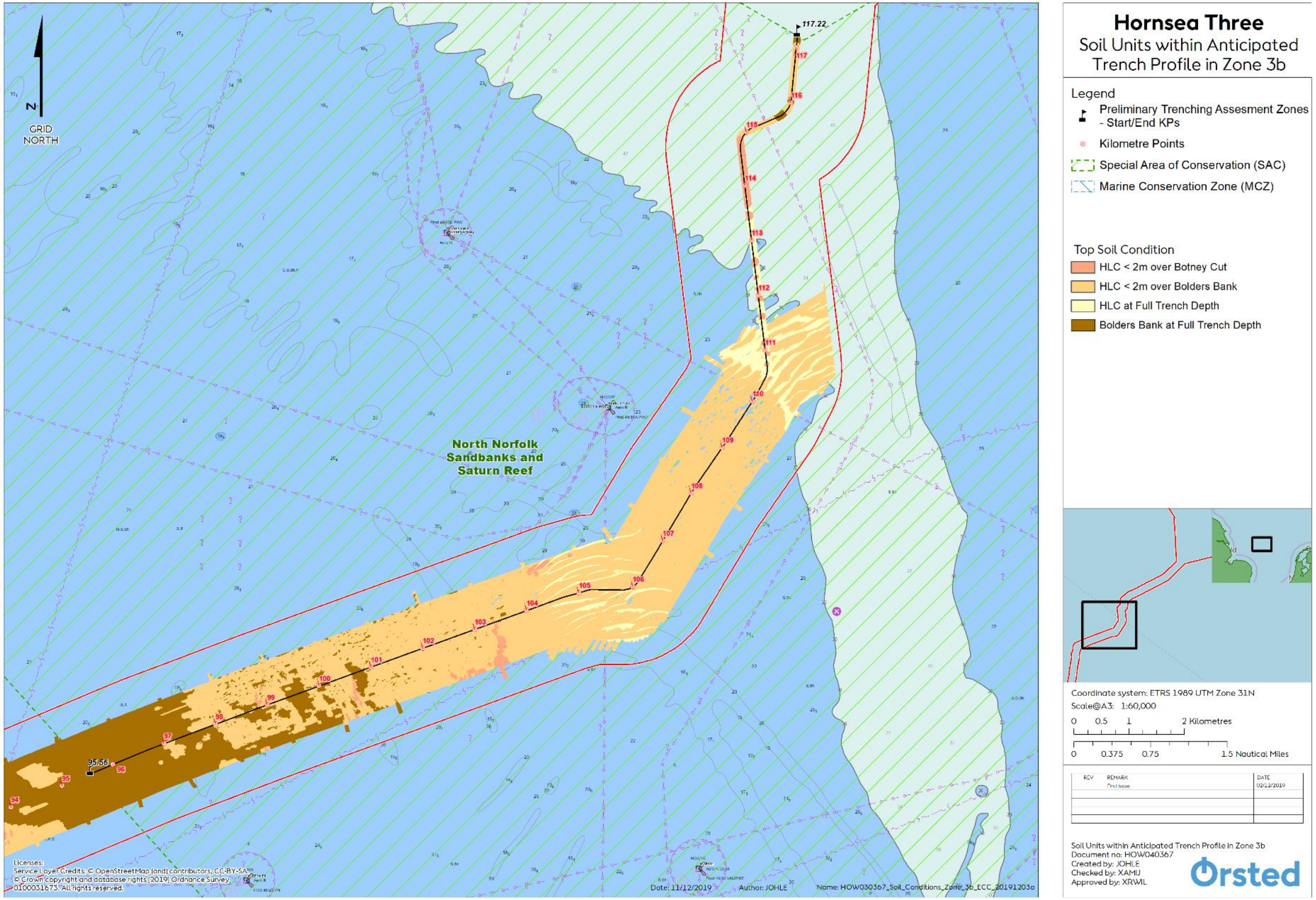
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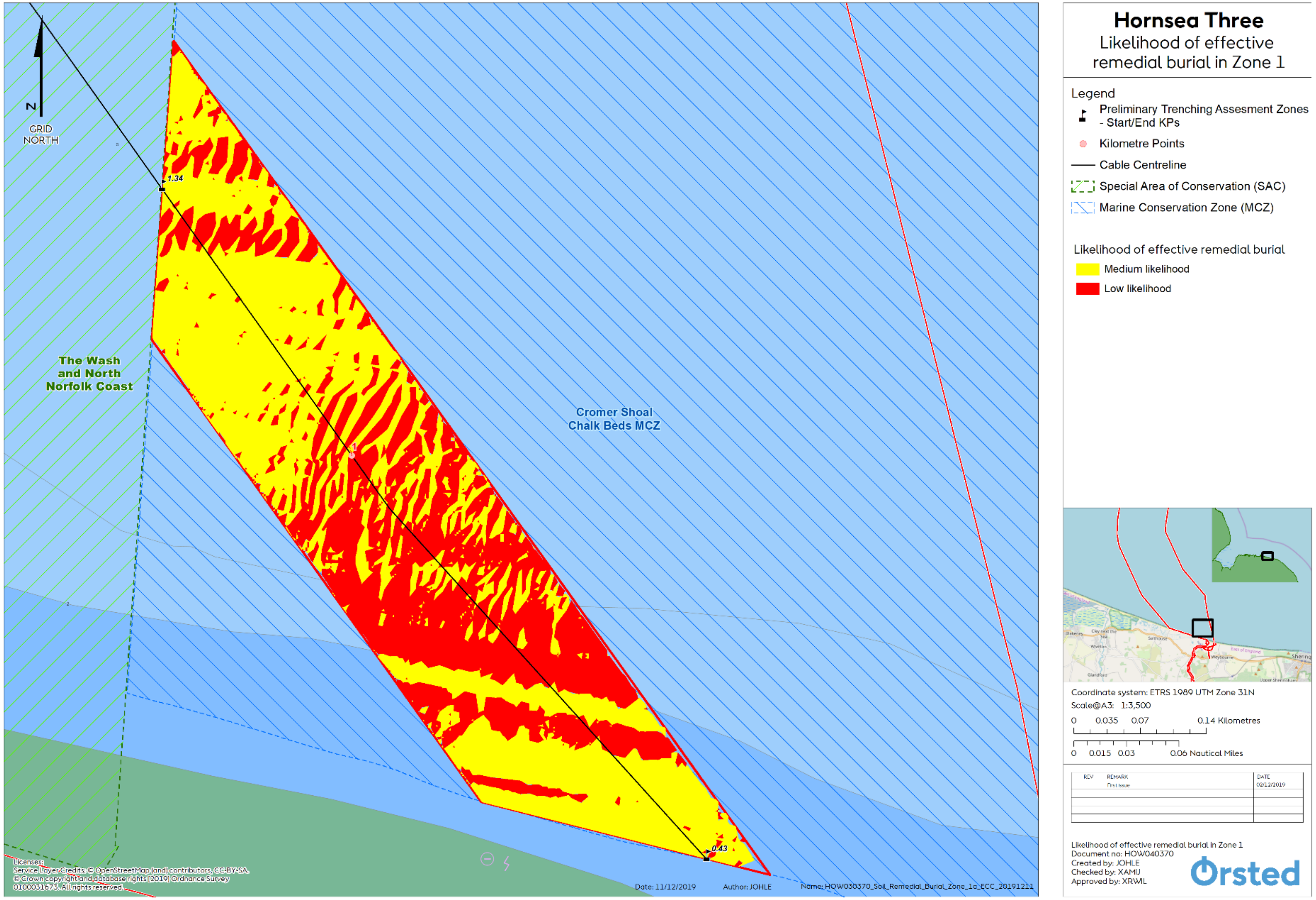
Appendix B Heat Maps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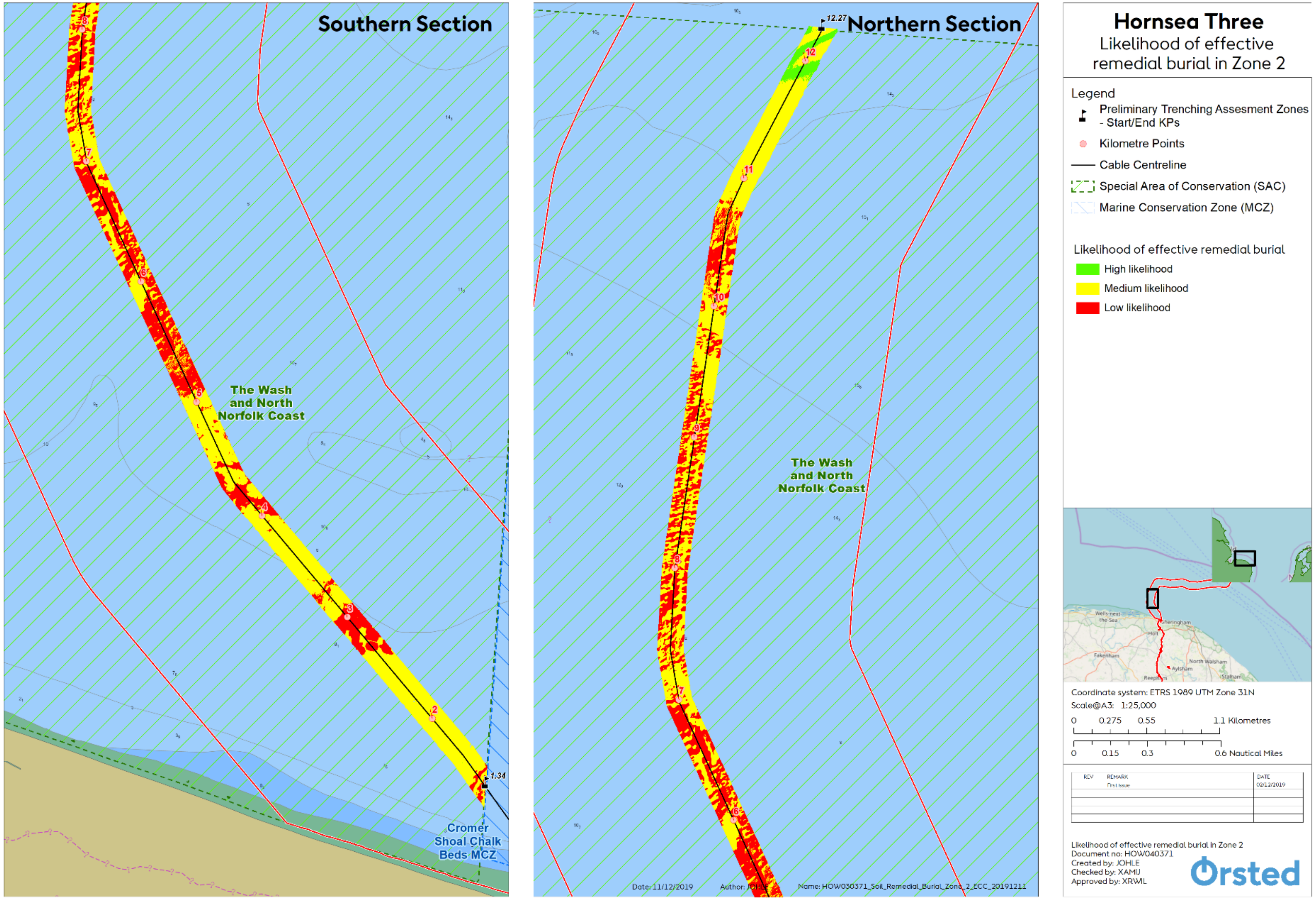
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Marine Conservation Zone (MCZ)
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Medium likelihood
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Holt
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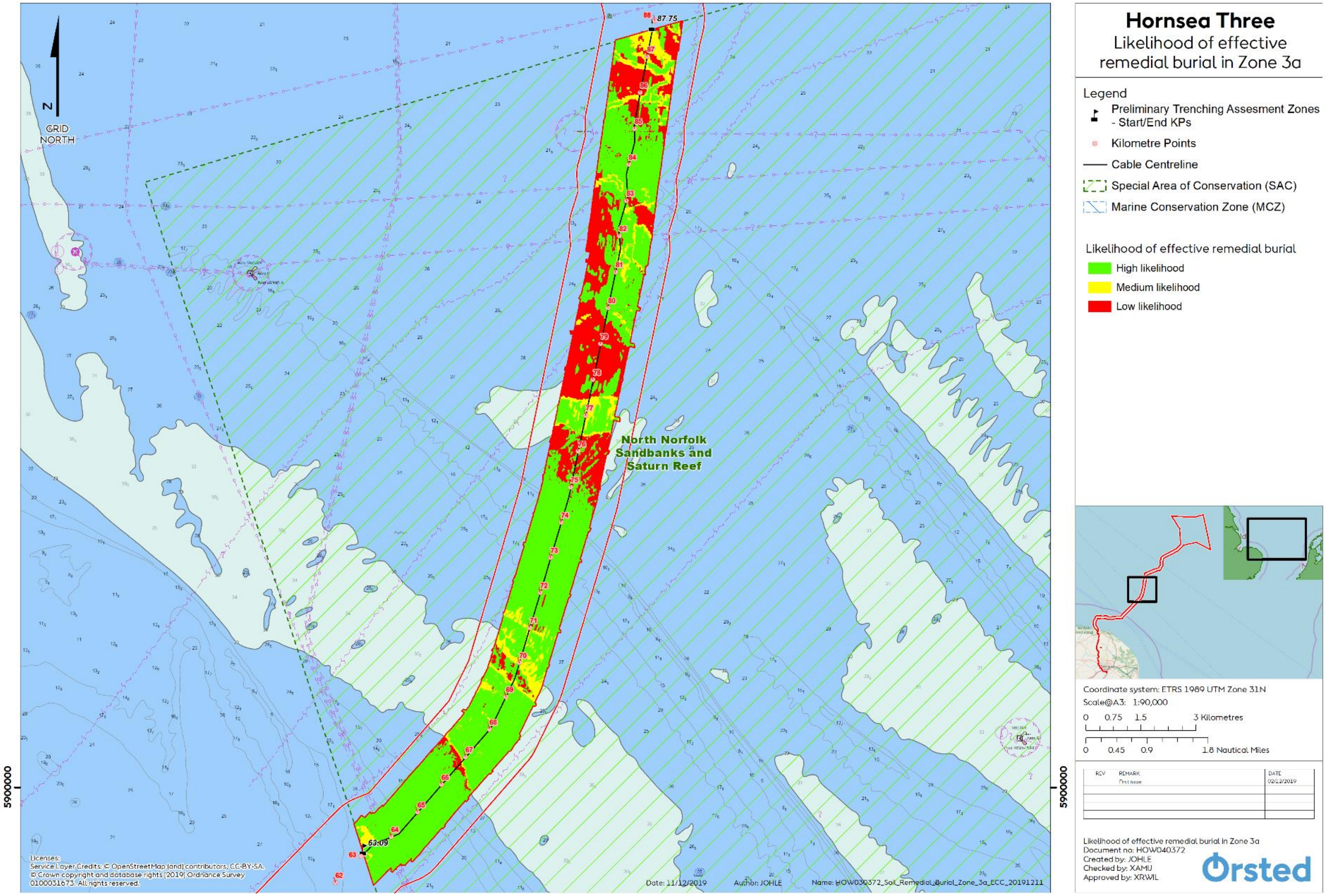
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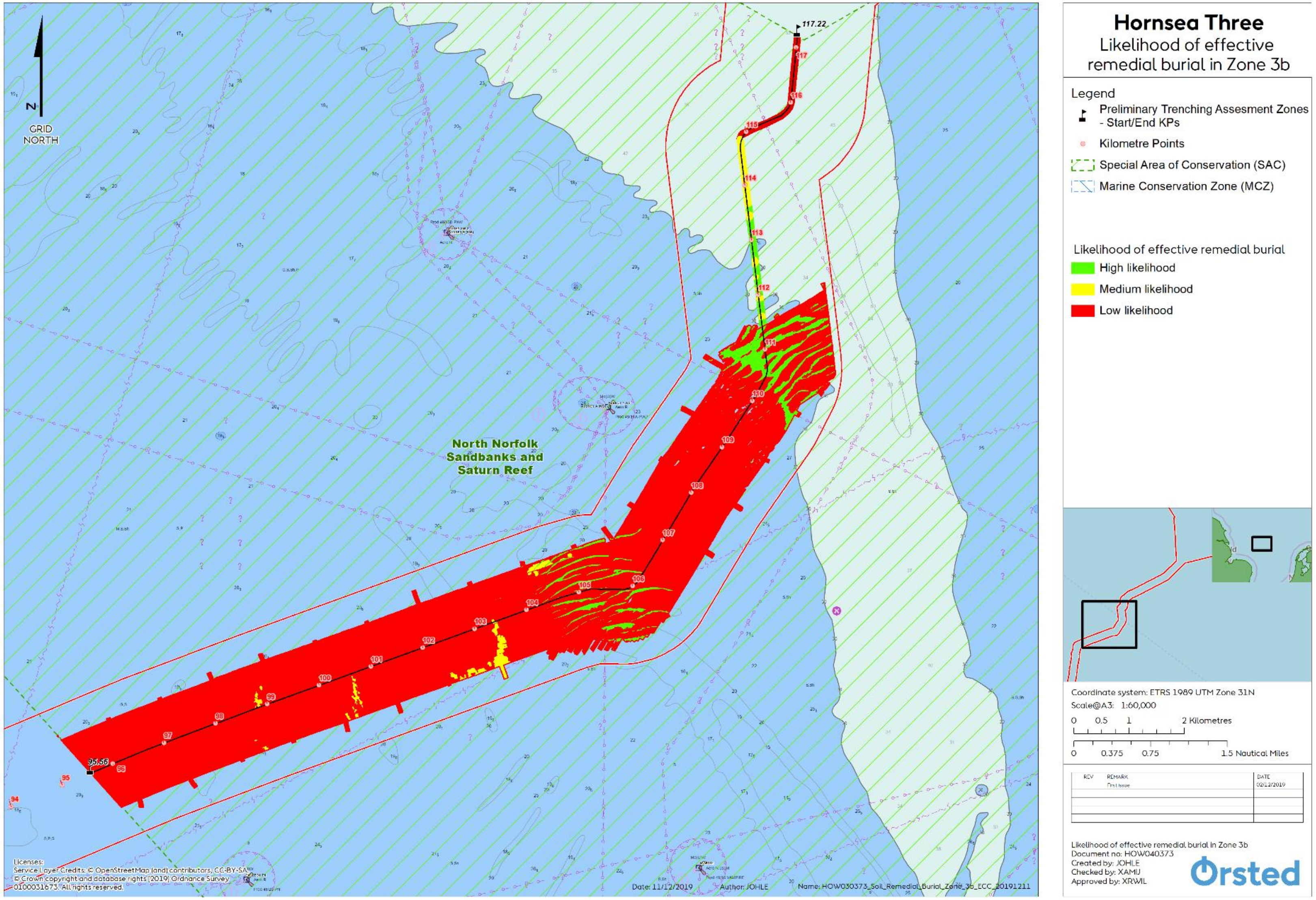
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Medium likelihood
Low likelihood
Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:60,000
0 0.5 1 2 Kilometres
0 0.375 0.75 1.5 Nautical Miles
Likelihood of effective remedial burial in Zone 3b
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Annex D: 2018/2019 Cable Engineering Site Specific Survey Data Overview

Hornsea Project Three
Offshore Wind Farm

Hornsea Project Three

Offshore Wind Farm

Response to the Secretary of State's Consultation
Appendix 4, Annex D: 2018/2019 Cable Engineering Site Specific Survey - Data Overview

Date: February 2020

Hornsea 3
Offshore Wind Farm

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Response to the Secretary of State's Consultation

Appendix 4 Annex D: 2018/2019 Cable Engineering Site Specific Survey - Data Overview

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1. Introduction

1.1 Hornsea Project Three collected site specific data in 2018 and 2019. The purpose of these surveys was to further inform engineering and cable installation requirements, particularly in the vicinity of the two offshore cable corridor re-routes, i.e. the nearshore re-route through the Wash and North Norfolk Coast (WNNC) Special Area of Conservation (SAC) and offshore re-route around the North Norfolk Sandbanks and Saturn Reef (NNSSR) SAC (both of which were put in place following Section 42 consultation). It should be noted that some of the data collected during these surveys (e.g. outputs from geophysical and geotechnical investigations) was previously presented within examination documents (i.e. the Preliminary Trenching Assessment; REP6-026), although further analysis of these datasets since examination have allowed the Applicant to further refine their project design parameters, particularly with respect to sandwave clearance volumes (discussed further below). As part of the geophysical surveys undertaken, benthic ecology data were also collected to validate the baseline presented within the Report to Inform Appropriate Assessment (RIAA; APP-051).

1.2 To ensure that these datasets were provided to Natural England, Joint Nature Conservation Committee (JNCC) and the Marine Management Organisation (MMO) in good time to inform discussions related to the Secretary of State's request for information this note was provided as an update to the baseline characterisation and a narrative of the implications of these datasets on the conclusions of the RIAA. This note has been provided as part of the Applicant's response to the Secretary of State in order that the Hornsea Three Report on the Implications for European Sites (RIES) can be updated with the latest baseline information and extents of habitats affected by cable installation, as set out in this note.

1.3 The site specific surveys completed in 2018 and 2019 comprised geophysical surveys and grab and drop down video (DDV) sampling across the two offshore cable corridor re-routes within the two SACs. Much of the geophysical information was presented during the examination phase as part of the Preliminary Trenching Assessment (REP6-026), including identification of seabed/sediment types and seabed features (e.g. sandwaves, subcropping chalk etc.). The text below provides a summary of the latest site specific data with specific reference to the WNNC and NNSSR SACs, noting any differences between the baseline characterisation presented in the DCO application.

1.4 It should be noted that the 2018 and 2019 survey data builds upon the baseline characterisation presented within the original application documents, with detailed geophysical information, grab and drop down video sampling collected across the remaining parts of the offshore cable corridor and presented within Volume 5, Annex 2.1: Benthic Ecology Technical Report (APP-102). This includes the most nearshore section of the offshore cable corridor which was characterised by a range of desktop and site specific survey data (see paragraph 4.1.4.83 of APP-102 and REP1-140).

2. Wash and North Norfolk Coast Data

2.1 Figure 2.1 below shows the extent of the geophysical interpretation and grab/DDV sampling locations within the WNNC SAC, relative to the baseline information discussed during the Hornsea Three examination (i.e. Figure 2.1 of the WNNC Clarification Note; REP1-140).

2.2 Based on the interpretation of the 2018 and 2019 survey data, Figure 2.2 presents the extents of sub-features of the Annex I sandbanks feature of the WNNC SAC as recorded within the Hornsea Three offshore cable corridor. The length of the offshore cable corridor through each of the Annex I sandbank sub-features as assumed within the DCO application is presented in Table 2.1, alongside the revised lengths within each sub-feature base on Figure 2.2 below (Note: the total corridor length through the Annex I sandbanks feature is unchanged).

Table 2.1: Length of offshore cable corridor passing through each of the Annex I sandbank sub-features of the WNNC SAC.

Annex I sandbanks sub-feature	Length of offshore cable corridor in DCO application (APP-051)	Length of offshore cable corridor based on latest data (see Figure 2.2)
Subtidal Coarse Sediment	2.1 km	1.7 km
Subtidal Mixed Sediment	5.7 km	1.9 km
Subtidal Sand	3.3 km	7.5 km
Total (Annex I sandbanks feature)	**11.1 km**	**11.1 km**

2.3 Grab sample data, DDV sampling and geophysical interpretation (Figure 2.1) show that the broadscale sediment types are broadly reflective of the baseline presented in the DCO application (APP-102) and validated in the WNNC Clarification Note (REP1-140). The main difference from the baseline presented in REP1-140, was the presence of subtidal sand sediments in the most offshore part of the WNNC SAC. In the DCO application, this was characterised as Subtidal Mixed Sediment, based on desktop data sources and taking a precautionary approach (i.e. assuming the more sensitive Subtidal Mixed Sediment Annex I sub-feature was present). The most recent site specific survey data (including grab and geophysical interpretation) have shown this to be overly conservative; i.e. the extent of Subtidal Mixed Sediments is less than that assumed in the DCO application, with the final ~2km of the offshore cable corridor within the WNNC SAC interpreted to be the Subtidal Sand sub-feature.

2.4 The latest site specific survey data showed that the remainder of the offshore cable corridor within the WNNC SAC was characterised by sands and gravels, with varying proportions of mud (i.e. Subtidal Coarse Sediment and Subtidal Mixed Sediments sub-features), in line with the characterisation in the DCO application. Smaller areas of more sandy sediments (i.e. Subtidal Sand sub-feature) also occurred in sections of this part of the offshore cable corridor. Therefore the characterisation of this part of the offshore cable corridor (i.e. as Subtidal Mixed Sediments) was considered to be accurate, or overconservative with regard to habitat sensitivity.

2.5 Areas of chalk were also identified interpreted in the geophysical interpretation (see Figure 2.1 below), although this was covered by a veneer of sand, and not comprising chalk reef habitat. This is consistent with the observations made during DDV surveys of sub-cropping chalk and chalk outcrops, as presented in the DCO application (see paragraph 4.1.4.87 et seq. of Volume 5, Annex 2.1: Benthic Ecology Technical Report; APP-102), and therefore there is no change to the RIAA with respect to presence of chalk reefs in the offshore cable corridor (i.e. these are not present).

2.6 The latest site specific survey data therefore confirm that the baseline characterisation presented in the DCO application was accurate, or overly conservative (i.e. assuming extents of the more sensitive Subtidal Mixed Sediment sub-feature were greater within the offshore cable corridor). As such, the data collected in these site specific surveys do not change the overall conclusions of the RIAA, rather they show that the effects on the Annex I sandbanks feature were overestimated in the RIAA.

Maximum design scenario update

2.7 As set out in section 1, based on the latest geophysical data for the offshore cable corridor re-route in the vicinity of the WNNC SAC, the Applicant has been able to reduce the maximum design parameters for sandwave clearance volumes within the SAC. This exercise was undertaken following the same methodology set out in the Sandwave Clearance Clarification Note (REP1-183), although incorporating the latest site specific geophysical and geotechnical datasets. This has resulted in a substantial reduction of volume of material which would need to be disposed of within the SAC, from 132,737 m^3 to 48,000 m^3. The implications of this reduction on the temporary habitat loss/disturbance calculations within the WNNC SAC are set out in Table 2.2 below, with an overall reduction in the maximum temporary habitat loss/disturbance footprint, i.e. 2,187,240 m^2, which represents 0.20% of the total area of the Annex I sandbanks habitat feature within the WNNC SAC (previously temporary habitat loss within the Annex I sandbanks habitat feature of the WNNC SAC was up to 2,356,714 m^2 or 0.22% of the total area of this Annex I feature).

2.8 With respect to the maximum design scenario for each of the sub-features, Table 2.3 below provides a breakdown of the temporary habitat loss/disturbance during the construction phase, operation and maintenance phase. This is a revised version of Table 2-1 of The Wash and North Norfolk Coast SAC In-combination Assessment (REP3-024), but with habitat loss/disturbance areas updated for the construction phase. This has resulted in an increased footprint in the Subtidal Sand feature (with faster recovery rates associated with this sub-feature) and a reduction in temporary habitat loss effects in the Subtidal Coarse Sediment and Subtidal Mixed Sediment sub-features (which have longer recovery times). Temporary habitat loss/disturbance areas are unchanged for the Annex I sandbanks feature of the WNNC SAC as a whole, as that presented within the RIAA (other than the reduction in sandwave clearance volumes outlined above). Note: temporary habitat loss/disturbance areas during the operation and maintenance phase within each sub-feature are unchanged from REP3-024, as it is not possible to specify where the remedial works may take place, therefore the maximum design scenario assumes that all habitat loss occurs wholly within one or other of the sub-features.

2.9 The reduction in the maximum design scenario outlined in Table 2.2 for the Annex I sandbanks feature as a whole and the amendments to the maximum design scenario for the individual sub-features outlined in Table 2.3 (with lesser effects on more sensitive sub-features) confirm the conclusion that Hornsea Three will not result in an adverse effect on integrity of the WNNC SAC, as presented in the RIAA.

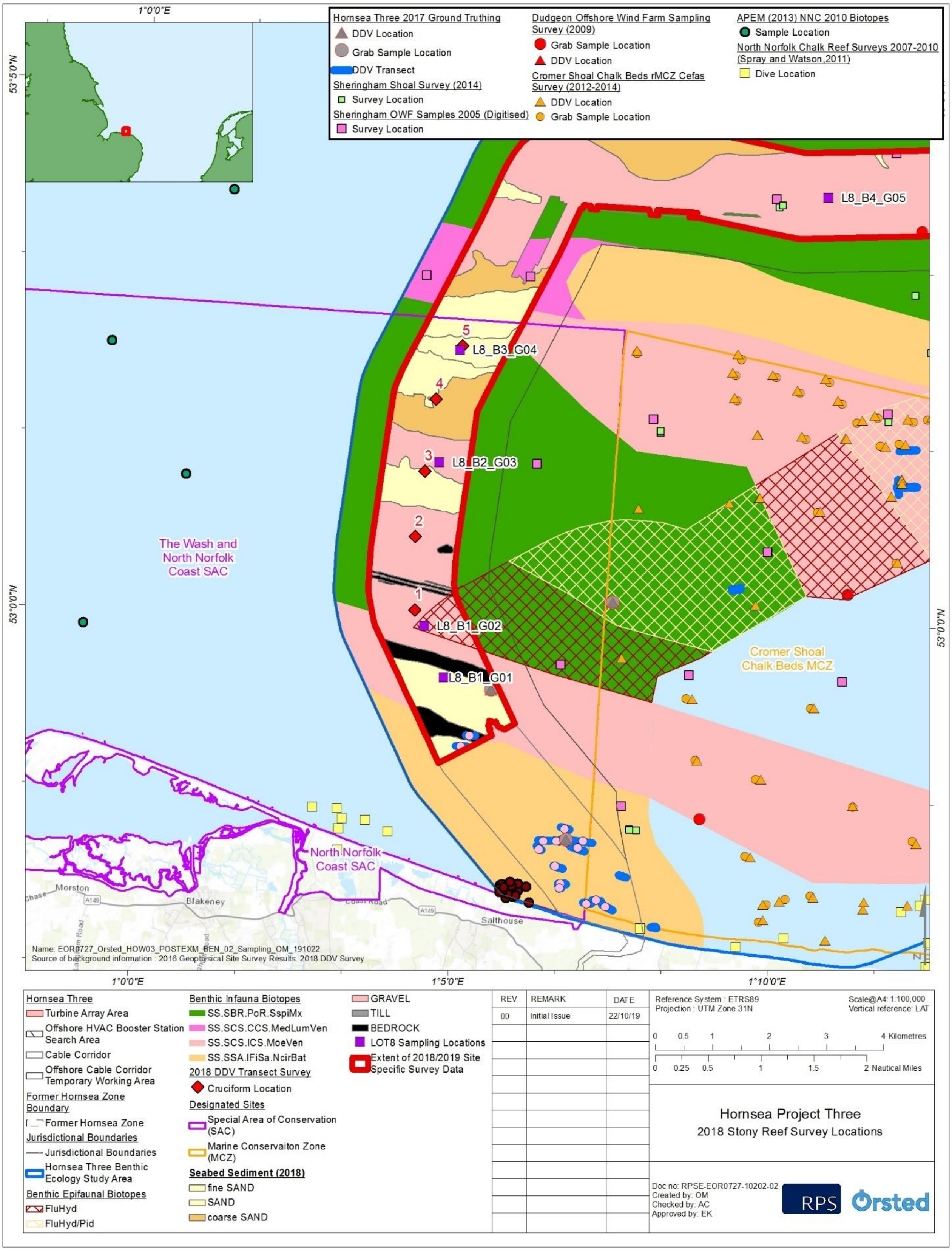

Figure 2.1: Geophysical interpretation and grab/DDV sampling locations within the WNNC SAC, relative to baseline presented within the Hornsea Three examination (i.e. Figure 2.1 of the WNNC Clarification Note; REP1-140)

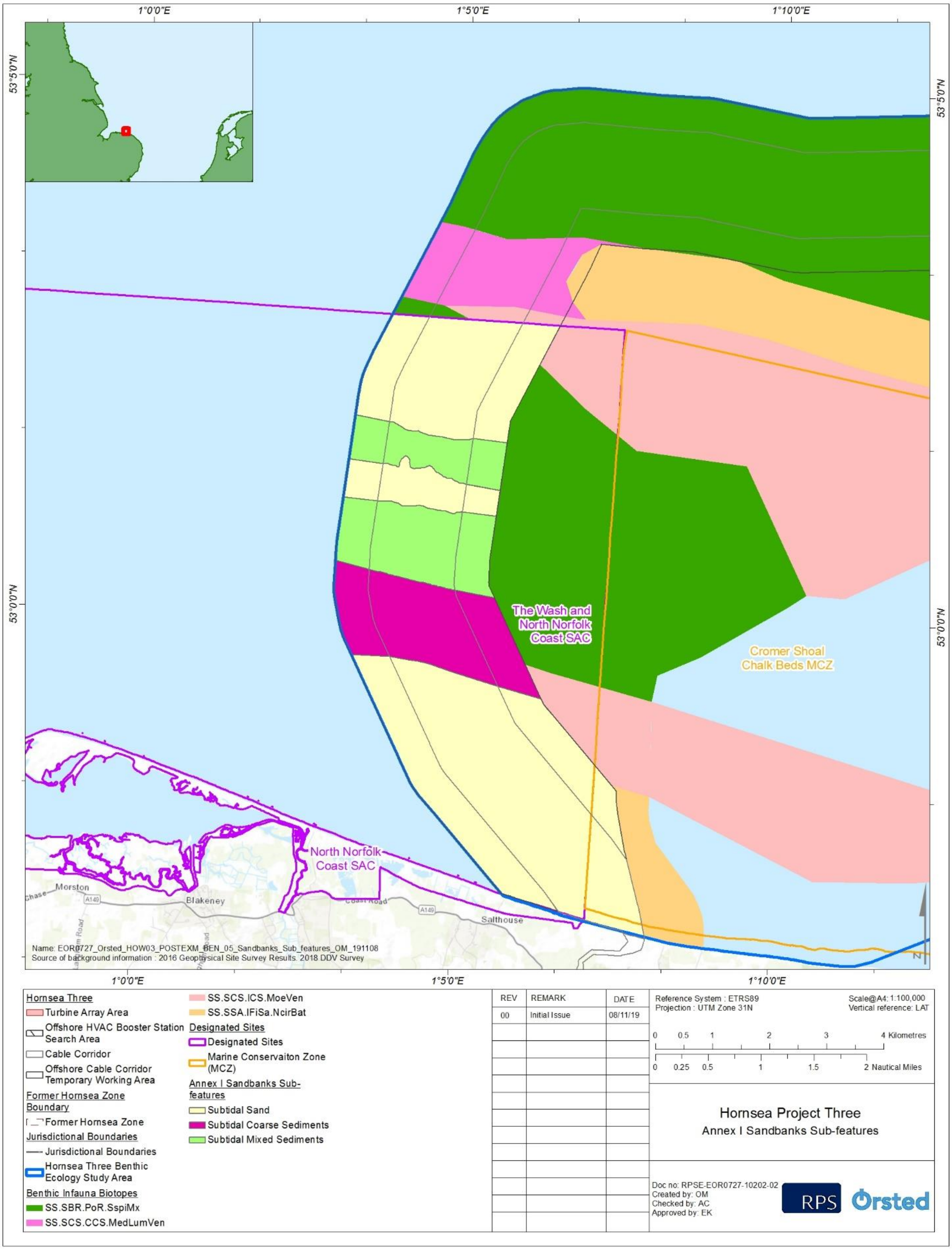

Figure 2.2: Extent of Annex I sub-features of the WNNC SAC within the Hornsea Three offshore cable corridor.

Table 2.2: Maximum temporary habitat loss/disturbance during the construction phase on Annex I sandbank feature of WNNC SAC.

Project Element	Maximum temporary habitat loss/disturbance (m^2)	Maximum Design Assumptions
Pre-construction sandwave clearance	999,000	Clearance of sandwaves along up to 66.6 km of cable, with up to six cables, each of up to 11.1 km length within WNNC SAC. Sandwave clearance will affect a corridor of up to 30 m width of seabed (i.e. an additional 15 m width of disturbance on the 15 m associated with cable burial) (66,600 m x 15 m = 999,000 m^2)
Pre-construction sandwave clearance disposal activities	96,000	Up to 96,000 m^2 from placement of dredged material to a uniform thickness of 0.5 m because of sandwave clearance on the offshore cable corridor, assuming a volume of up to 48,000 m^3 of sandwave clearance material.
Cable burial	999,000	Burial of up to a total of 66.6 km cable length, with up to six cables, each of 11.1 km length within WNNC SAC. Cable installation will affect a corridor of up to 15 m width of seabed (66,600 m x 15 m = 999,000 m^2).
Anchor placements	93,240	Up to seven anchors (each with a footprint of 100 m^2) repositioned every 500 m of the 66.6 km cable length within WNNC SAC, with up to six export cables (11,100 m x 100 m^2 x 7 x 6 / 500 m = 93,240 m^2).
Total temporary habitat loss/disturbance within WNNC SAC	**2,187,240**	**Equates to a maximum of 0.20% of the total area of the WNNC SAC.**

Table 2.3: Maximum temporary habitat loss/disturbance during the construction phase, operation and maintenance phase and project lifetime for sub-features of the Annex I sandbank feature of The Wash and North Norfolk Coast SAC (based on latest extents outlined in Figure 2.2).

Sub-feature of Annex I sandbanks	Temporary habitat loss/disturbance (m^2) during construction (proportion of sub-feature affected within SAC)	Temporary habitat loss/disturbance (m^2) during operation and maintenance (proportion of sub-feature affected within SAC)	Temporary habitat loss/disturbance (m^2) across entire project lifecycle (maximum proportion of sub-feature affected within SAC)	Assumptions
A5.2 Subtidal Sand	1,509,000 (0.26%)	198,838 (0.03%)	1,707,838 (0.30%)	Assumes cabling through 7.5 km of Subtidal Sand, 1.7 km of Subtidal Coarse Sediment and 1.9 km of Subtidal Mixed Sediment sub-features. 6 export cables, each affecting a corridor of up to 30 m (i.e. 15 m for cable burial, plus an additional for sandwave clearance, where required). Up to seven anchor placements (each 100 m^2) repositioned every 500 m. Assumes sandwave material disposed entirely within each one of the sub-features.
A5.1 Subtidal Coarse sediment	416,280 (1.16%)	198,838 (0.55%)	615,118 (1.71%)	
A5.4 Subtidal Mixed Sediment	453,960 (0.58%)	198,838 (0.26%)	652,798 (0.84%)	

3. NNSSR SAC

3.1 Figure 3.1 below shows the extent of the geophysical interpretation and grab/DDV sampling locations within the NNSSR SAC from the 2018 and 2019 datasets, relative to the latest baseline information discussed during the Hornsea Three examination (i.e. Figure 1.1 of Clarification of Biotope Classifications in NNSSR SAC; REP7-022).

3.2 For the NNSSR SAC, the majority of the offshore cable corridor re-route is located outside the SAC boundary, with only approximately 4 km of the latest survey data located within the NNSSR SAC. The site specific grab, DDV and geophysical interpretation (Figure 3.1) showed that this part of the SAC is characterised primarily by fine sandy sediments. Particle size, benthic infauna and seabed imagery data from sampling location L5_B1_G01 reflected the baseline characterisation presented within the DCO application and discussed during the Hornsea Three examination (e.g. Figure 1.1 of REP7-022), with impoverished sandy sediments recorded at this location in the latest site specific survey data.

3.3 At location L5_B2_G02 (located on the boundary of the SAC) sediments were found to contain a greater proportion of fine sediments, than recorded in the previous surveys (e.g. sampling location ECR52, located in very close proximity). During the latest survey, sediments at this location were characterised as mud and sandy mud, according to the simplified Folk classification (Long, 2006). While the original characterisation within the DCO application classified this area as a mixed sediment biotope (based on site specific grab sampling undertaken in 2017), biotopes associated with mud and sandy mud were recorded in other parts of the NNSSR SAC (e.g. the SS.SMu.CSaMu.AfilMysAnit biotope). However, both muddy and mixed sediments are considered to comprise part of the Annex I sandbanks feature within the NNSSR SAC and therefore this does not change either the assessment or the overall conclusions of the RIAA.

3.4 Based on the latest geophysical data for the offshore cable corridor re-route in the vicinity of the NNSSR SAC, the Applicant revisited the maximum design parameters for sandwave clearance volumes within the SAC. However, based on this revisiting of the volumes, it has not been possible to reduce the maximum design scenario from that assumed within the RIAA i.e. 619,700 m^3. As such, the assessment within section 5.6 of the RIAA and conclusions that Hornsea Three would not lead to an adverse effect on integrity of the site is unchanged.

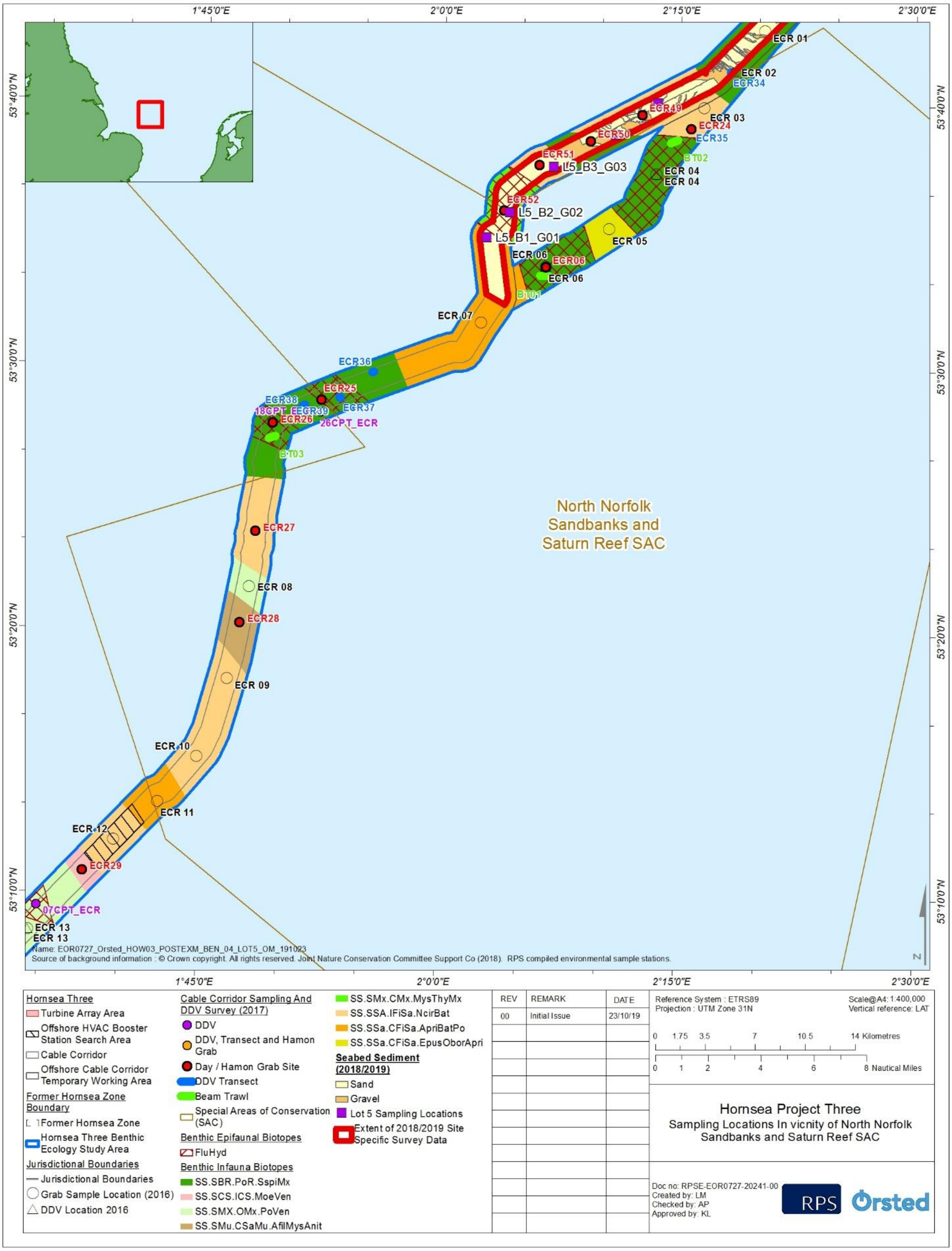

Figure 3.1: Geophysical interpretation and grab/DDV sampling locations within the NNSSR SAC, relative to baseline presented within the Hornsea Three examination (i.e. Figure 1.1 of Clarification of Biotope Classifications in NNSSR SAC; REP7-022).